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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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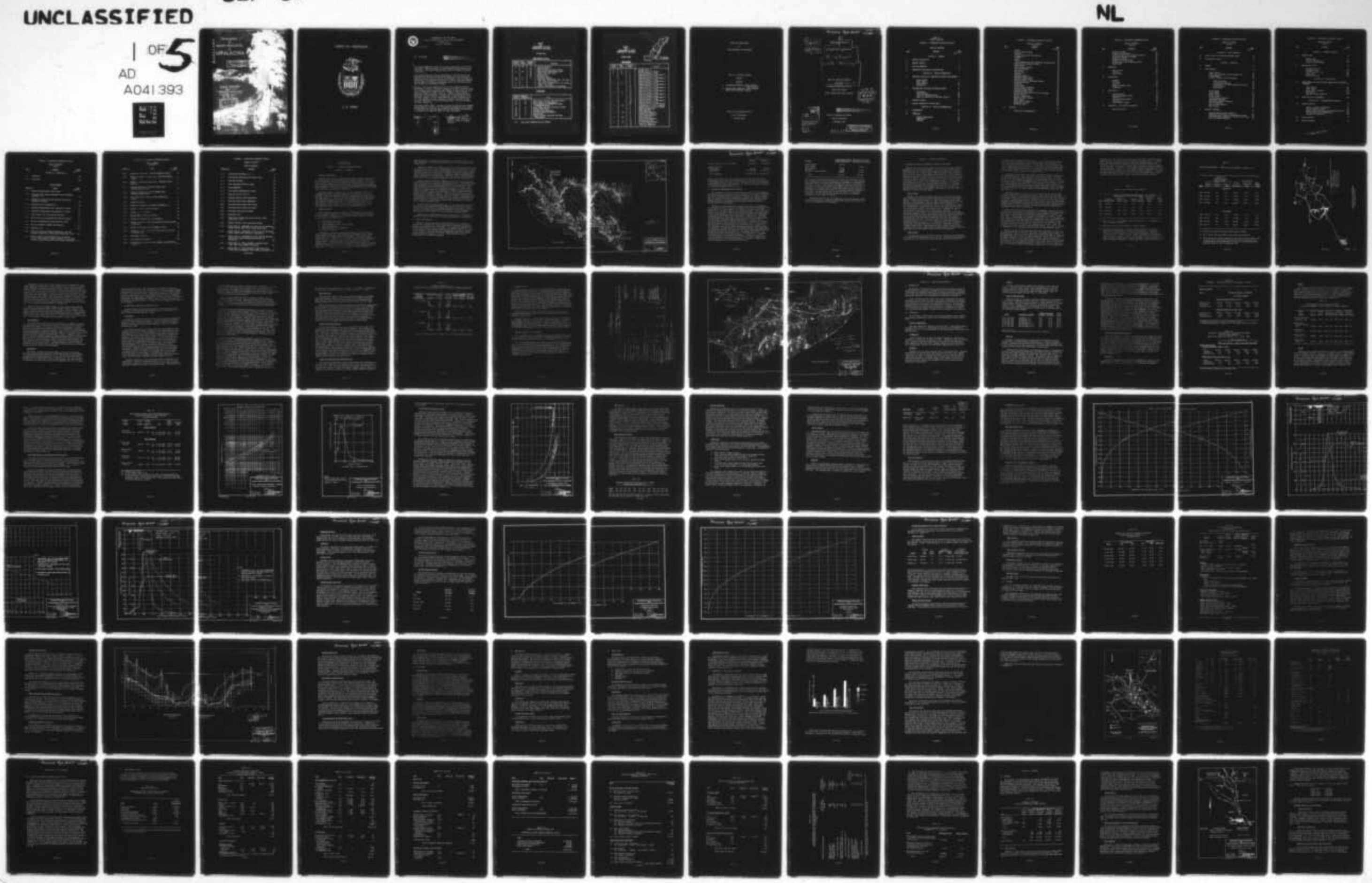

Development of WATER RESOURCES in APPALACHIA

MAIN REPORT
PART III
PROJECT ANALYSES
CHAPTERS 5 thru 7

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TO: THE READER

This volume ~~(Number 7)~~ is one of six that comprise Part III, "Project Analyses", to the Main Report for Development of Water Resources in Appalachia. The volume contains three of the 20 chapters that make up Part III.

Each chapter generally contains information on how the project was formulated and designed; its estimated costs; the type and value of benefits expected; and the indices of performance. Also included, as appropriate, is information on sharing of project costs among Federal and non-Federal interests, coordination carried out during the planning process, and conclusions reached.

Chapters 5 and 6 were prepared by the U.S. Army Engineer District, Charleston. Chapter 5, Clinchfield Reservoir Project, presents a plan for a multiple purpose reservoir development on Broad River, 18 miles north of Spartanburg, South Carolina. Chapter 6, Roaring River Reservoir Project, presents a plan for a multiple purpose reservoir development on Roaring River, 50 miles west of Winston-Salem, North Carolina. Chapter 7, Curry Creek Reservoir Project, prepared by the U.S. Army Engineer District, Savannah, presents a multiple purpose reservoir development on the North Oconee River, 10 miles northwest of Athens, Georgia.

The Summary Report (Part I, Volume 1) should be consulted for recommendations made as a result of the information presented in this volume. A volume index for the Main Report and its nine supporting Appendices is included on the next two pages for your convenience.

JOHN C. H. LEE, JR.
Colonel, Corps of Engineers
Director

REPORT
For
DEVELOPMENT FOR WATER
RESOURCES IN APPALACHIA

VOLUME INDEX

MAIN REPORT (cont'd)

Volume Number	Part Number	Chapter Number	Contents
10	III	14	Whiteoak Reservoir
		15	Logan Reservoir
		16	Midland Local Protection Project
11	III	17	Upper French Broad System (TVA)
		18	Yellow Creek Port (TVA)
		19	Otocsin (Pa.)
		20	Naturealm (Pa.)
12	IV	-	Concepts & Methods
13	V	-	State Water Supplements: Ala., Ga., Ky., Md., Miss., N.Y., N.Car.
14	V	-	State Water Supplements: O., Pa., S.Car., Tenn., Va., W.Va.
15	VI	-	History, Coordination & Cooperation

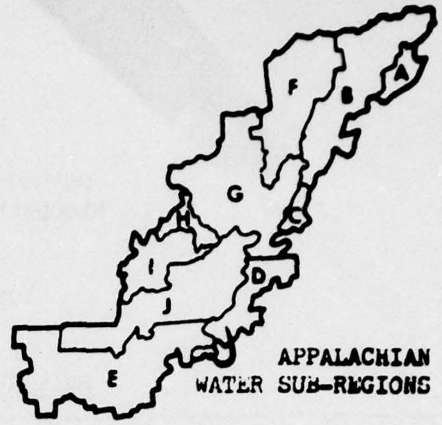
APPENDICES

Volume Number	Appendix Designation	Title
16	A	Agriculture, Forestry and Conservation
17	B	Power Supply and Requirements
18	C	The Incidence and Formation of Mine Drainage Pollution
19	D	Water Supply and Water Pollution Control
20	E	Economic Base Study
21	F	Recreation and Aesthetics
22	G	Fish and Wildlife Resources
23	H	Ground Water
24	I	Mineral Industry Resources and Water Requirements

25 Loose Leaf Volume-Errata and Addenda

REPORT
For
DEVELOPMENT OF WATER
RESOURCES IN APPALACHIA

VOLUME INDEX



MAIN REPORT

Volume Number	Part Number	Chapter Number	Contents
1	I	-	Summary Report
2	I	-	Key Map Folio (By States)
3	II	1	Water Sub-Region A Today
		2	Shaping the Plan for Sub-Region A
		3	Water Sub-Region B Today
		4	Shaping the Plan for Sub-Region B
		5	Water Sub-Region C Today
		6	Shaping the Plan for Sub-Region C
4	II	7	Water Sub-Region D Today
		8	Shaping the Plan for Sub Region D
		9	Water Sub-Region E Today
		10	Shaping the Plan for Sub-Region E
		11	Water Sub-Region F Today
		12	Shaping the Plan for Sub-Region F
5	II	13	Water Sub-Region G Today
		14	Shaping the Plan for Sub-Region G
		15	Water Sub-Region H Today
		16	Shaping the Plan for Sub-Region H
		17	Water Sub-Region I Today
		18	Shaping the Plan for Sub-Region I
		19	Water Sub-Region J Today
		20	Shaping the Plan for Sub-Region J
6	III	1	Introduction to Project Analyses
		2	Tamaqua Local Protection Project
		3	Royal Glen Reservoir
		4	Hipes Reservoir
7	III	5	Clinchfield Reservoir
		6	Roaring River Reservoir
		7	Curry Creek Reservoir
8	III	8	Dalton Reservoir
		9	Coosa River Navigation
		10	Stannard Reservoir
9	III	11	St. Petersburg Reservoir
		12	Greenbrier Reservoirs
		13	Lower Knox Reservoir

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

VOLUME 7

CHAPTERS:

Office of Appalachian Studies

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October 1969

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6 REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA.

Main Report.

Part III. Volume 7.

PART III - PROJECT ANALYSES.

CHAPTER 5 thru 7.

CLINCHFIELD RESERVOIR PROJECT

BROAD RIVER BASIN

NORTH CAROLINA AND SOUTH CAROLINA

Office of Appalachian Studies

Corps of Engineers

September 1969

410 111

PART III
PROJECT ANALYSES

CHAPTER 5 - CLINCHFIELD RESERVOIR PROJECT

TABLE OF CONTENTS

CHAPTER 5 - CLINCHFIELD RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

TABLE OF CONTENTS
(Cont'd)

CHAPTER 5 - CLINCHFIELD RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

TABLE OF CONTENTS
(Cont'd)

TABLE OF CONTENTS
(Cont'd)

LIST OF TABLES

LIST OF TABLES
(Cont'd)

CHAPTER 5 - CLINCHFIELD RESERVOIR PROJECT

TABLE OF CONTENTS

LIST OF EXHIBITS

PART III
PROJECT ANALYSES

CHAPTER 5 - CLINCHFIELD RESERVOIR PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Rutherford and Polk Counties, North Carolina, and Spartanburg County, South Carolina, and the Piedmont physiographic province are the locale of the Clinchfield multi-purpose reservoir project. The impoundment would be created by a dam at mile 130 on the Broad River, a headwater tributary of the Santee River, about 18 miles north of Spartanburg, South Carolina. The area draining into the reservoir would be 571 square miles. The site is depicted on exhibit 5-1.

Principal elements of the project are the 3,430-foot earth fill embankment which has a maximum height of 153 feet; a gated 300-foot spillway in the left abutment; a double 20-foot diameter conduit near the river channel a 210-foot saddle dike; recreation facilities requiring 4,000 additional acres adjacent to the reservoir, and 4,000 acres for wildlife mitigation measures. The reservoir has a shoreline of about 386 miles and an area of 20,220 acres at the top of the conservation pool, and a capacity of slightly over a million acre-feet (34 watershed inches) at the top of the flood control pool.

2. PROJECT IMPACTS

This reservoir project is designed to provide the water resource goods and services necessary to remove the constraints to realization of the potential development of the affected area. Specific benefits of the project were identified as:

a. Flood damage reduction
b. Bountiful water supply
c. Flow augmentation for quality control
d. Outdoor recreation
e. Fish and wildlife enhancement
f. Economic expansion

Development of the water resource potential of this site would fully control floods up to and including the standard project flood. Substantial flood damages would be eliminated to the mouth of the Pacolet River - a distance of 52 miles below the Clinchfield Reservoir. Flood protection in the remaining 78 miles of Broad River would be to a lesser degree. Stage reductions varying from 0.5 to 1.5 feet at Columbia, South Carolina, would be realized from major floods of record. Other areas would be freed from recurrent erosion by overbank flows and deposition of infertile silt which presently preclude profitable

agricultural use. Reclamation and intensive cultivation of these areas will substantially increase production and income in those areas which remain rural.

Based on benchmark projections of growth of the population and industry in the seven-county area surrounding the site, the storage in Clinchfield Reservoir would assure an ample supply for the area's water supply systems at least to the year 2020. Clinchfield Reservoir storage would also furnish adequate streamflows to ameliorate future downstream water quality problems in the Broad River. The effective low flow augmentation would extend about 100 miles downstream to the vicinity of Parr, S.C.

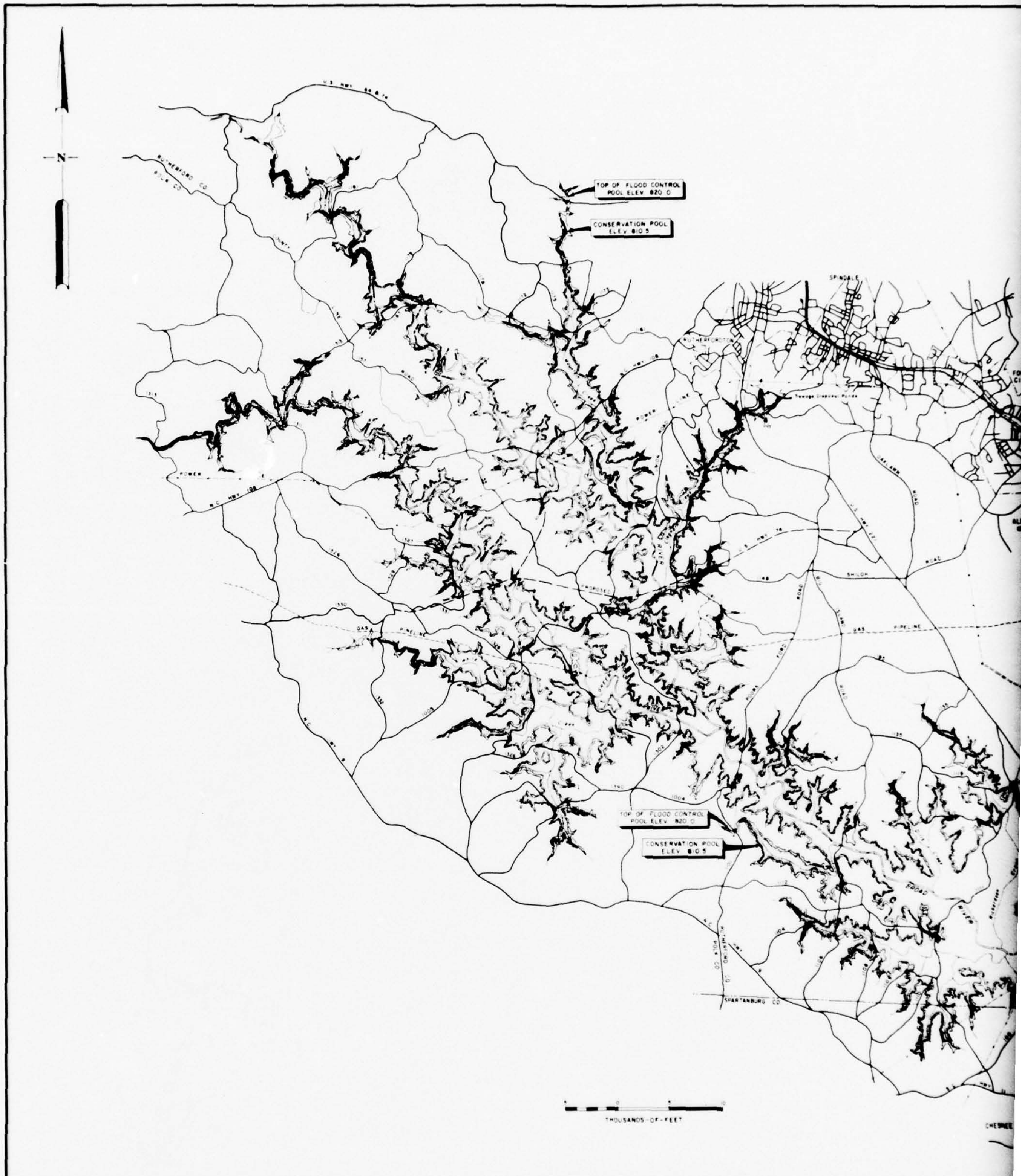
Another growth stimulant is expected to be that resulting from the recreation development centered around the reservoir. With optimum recreation facilities, the recreation participation is expected to increase from 570,000 recreation days initially to 5.7 million by 2000. The recreation facilities of the project are expected to satisfy demands which will greatly exceed the capability of existing recreation developments and those soon to become available. Fishery resources without the project are of moderate to low value with an expected average of 8,900 man-days of fishing annually. With the project, fishery resources are expected to increase to 226,400 annually. Wildlife mitigation will be provided by the purchase of 4,000 acres of land located outside the project adjacent to the general purchase unit boundaries of the Green River Wildlife Management Area.

Releases during normal operation and low flow augmentation periods will sustain the streamflow at much higher levels than under natural conditions during normal and subnormal seasonal deficiencies. This will alleviate conditions in downstream reaches which would otherwise be aesthetically unacceptable to recreationists and residents alike.

Altogether, the goods and services of this project are expected to catalyze the growth potential of the area and lead to its realization.

3. COSTS AND BENEFITS

Costs of constructing the Clinchfield Reservoir are estimated at $58,565,000, including the future recreational increment, and annual charges are estimated to be $2,416,000. The economic development which can be related to the reservoir project, as outlined above, will cost on the order of $554.5 million with average annual equivalent charges of $16,799,000, and associated water transmission costs with average annual equivalent charges of $475,000. Annual benefits for the development are estimated as follows:



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SHILOH
GAS
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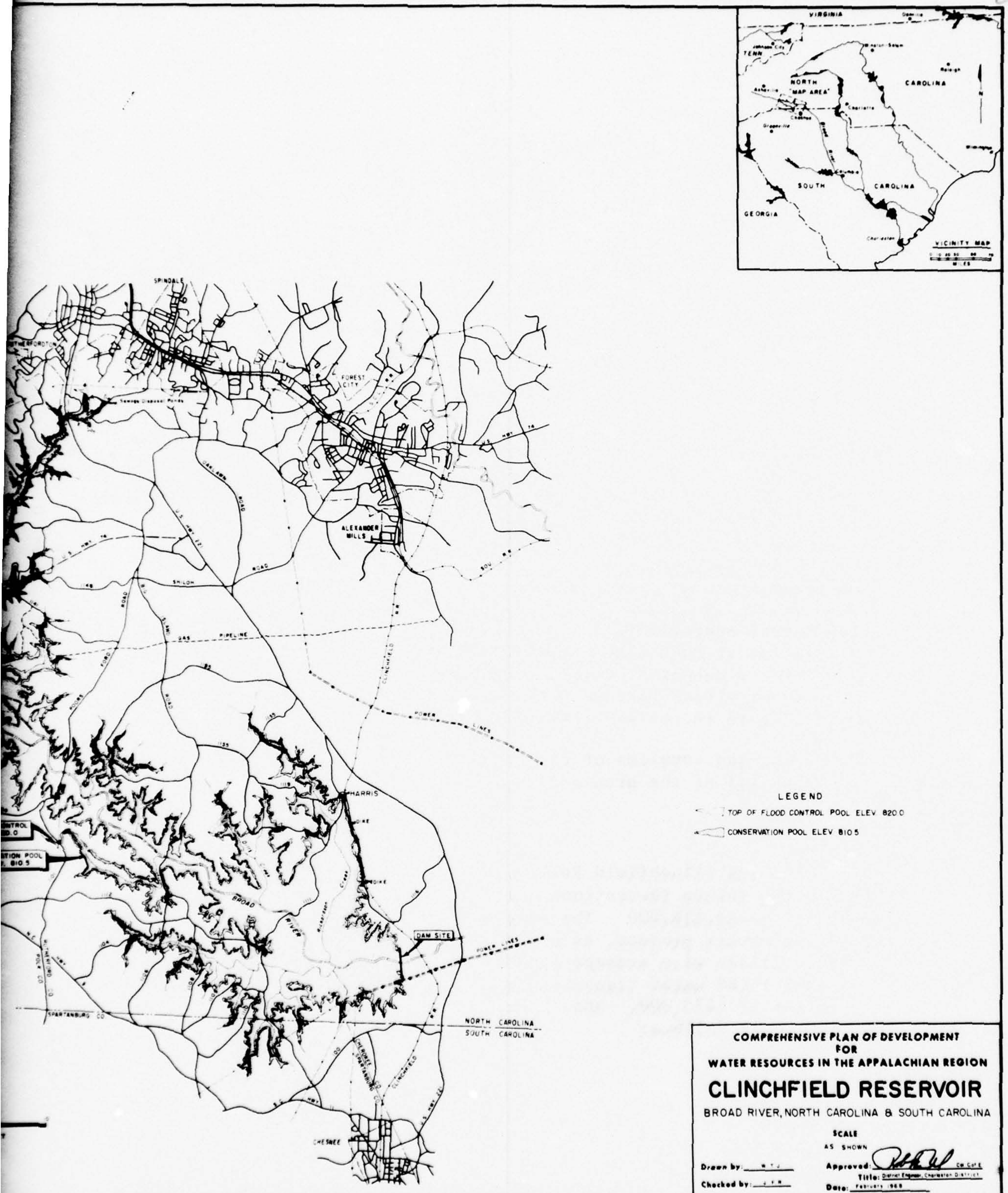
BROAD
RIVER
SPARTANBURG CO
THOUSANDS OF FEET



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD RESERVOIR

BROAD RIVER, NORTH CAROLINA & SOUTH CAROLINA

SCALE
AS SHOWN

Drawn by: W T J
Checked by: J T R
Approved: Col CE
Title: District Engineer, Charleston District
Date: February 1968

EXHIBIT 5-1

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	Income National	Income Regional
Users of the Water Project Services	$ 4,789,000	$ 3,820,000
Expansion Effects		
Redevelopment	166,000	731,000
Development	112,829,000	117,598,000
Total Expansion	$112,995,000	$118,329,000

Using the preceding, the ratio of user plus redevelopment benefits to water project costs indicates a minimum index of performance in relation to increasing national income of 2.1. The ratio of total regional expansion benefits to total costs indicates an index of performance in regards to increasing regional income of 6.0.

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accordance with present Federal policy, costs of the Clinchfield Reservoir have been apportioned between Federal and non-Federal interests. The Corps of Engineers would construct and operate the project, except that it would share with the non-Federal interests the operation of the general outdoor recreation and fish and wildlife lands and facilities. Operation would be coordinated with interests acquiring rights to storage space for water supply.

Construction costs allocated to water supply would be apportioned to non-Federal interests who would reimburse the Federal Government under provisions of the Water Supply Act of 1958, as amended, (PL 85-500). Construction costs and operation and maintenance costs allocated to flood control would be apportioned to the Federal Government under applicable flood control legislation since flood control benefits are widespread, extending about 130 river miles downstream. Construction, operation, and maintenance cost allocated to water quality control is apportioned to the Federal Government under provisions of the Federal Water Pollution Control Act, as amended, (PL 84-660). The FWPCA has determined the need for and benefits of water quality control; such benefits are widespread, extending along about 100 river miles. One-half of the separable costs of recreation (including fish and wildlife enhancement measures) are apportioned to non-Federal interests, who must agree to operate and maintain the facilities and lands under provisions of the Federal Water Projects Recreation Act, as amended, (PL 89-72). The remaining separable costs and all joint costs allocated to recreation are apportioned to the Federal Government. A portion of the joint costs of the project were allocated to regional income expansion and are apportioned to the Federal Government. A summary of apportioned costs is presented in the following tabulation:

Purpose	Apportioned Construction Costs ($1,000) Federal Government	Non-Federal Interests
Flood Control	1,323	
Water Supply		8,556
Water Quality	2,111	
Recreation	22,548	14,064
Regional Income Expansion	9,963	
Total	$35,945	$22,620

The States of North Carolina and South Carolina have indicated support of the reservoir project as formulated and willingness to undertake the responsibility for providing the assurances required of non-Federal interests. Prior to construction, non-Federal interests should furnish assurances to repay their share of the apportioned costs; establish downstream encroachment lines to permit efficient reservoir regulation; contribute to the pollution control by providing adequate treatment or other waste control methods; and to the full extent of their legal capability, and exercise control against diversion of streamflow available for water quality control.

Non-Federal agencies are also required to hold and save the United States free from water rights and other damage claims arising from construction and operation of the project.

5. POTENTIAL SOLUTION OF PROBLEMS BY PROJECT DEVELOPMENT

The need for water control measures is identified by describing the problems in the following paragraphs. Water control problems of the Broad River are not confined to the Appalachian Region, but extend to below the mouth of the Tyger River, where pollutants from the Spartanburg area will create increasingly serious conditions above Columbia. Analyses of the growth potential of the project area, presented in Part II of this report, revealed a potential for substantial economic expansion of this area, provided the needed water resource control, and development was provided. The Clinchfield Reservoir could supply the greater portion of the water control measures needed in the region. This would be accomplished by transporting water from the reservoir to the major growth areas of Spartanburg and Greenville Counties. A schematic of water needs and alternate solutions is shown on Figure 8-7, Chapter 8 in Part II of this report.

Flood Control

Present flood damages primarily are borne by agricultural lands. Urban development and the attendant highway network in the Broad River Basin is limited almost entirely to upland areas along the drainage divides. In recent years there has been a considerable amount of urban and industrial development that has taken place at Gaffney, S. C., and surrounding area. Consequently, much of the farmlands were taken out of production. During the last century many farms were located in the Broad River bottoms in this general area. Subsequently, many of these farms were abandoned due to the frequent flooding. It is reasonable to assume that as more upland farms give way to continued urban developments, farmers thus displaced may well consider relocating in the more productive Broad River bottom lands once they realize the potential flood risk has been lessened by the Clinchfield project. The estimated land areas of the flood plain are for: Rutherford and Cleveland Counties, N. C., 800 and 1,000 acres, respectively; and Cherokee and York Counties, S. C., 2,900 and 1,800 acres, respectively. These lands totaling 6,500 acres would receive protection from the standard project flood. Remaining flood plain lands of Broad River, totaling 12,800 acres, would receive a lesser degree of flood protection depending on their remoteness from the Clinchfield Reservoir.

Water Supply

A foreseeably critical deficit of water threatens the future growth of Greenville and Spartanburg, South Carolina. These growing metropolitan areas are near the Santee River system divide, and obtain water from

streams of small drainage area and yield. At present Greenville obtains its water from tributaries of the Saluda, and Spartanburg obtains its water from the South Pacolet River. In 1965 these two cities were using about 40 mgd, but the two systems were continuing to increase their service areas. The maximum capacity of the two source streams is about 100 mgd. Each city has indicated an interest in obtaining a source having an additional yield of about 100 mgd at favorable costs.

To bracket water supply needs that can possibly be met by storage in Clinchfield Reservoir, tables 5-1 and 5-2 have been prepared to project, in the first case, the water demands of a seven-county area, and in the second case, the demands of Greenville and Spartanburg Counties. Inherent in these projects are the assumptions that: (1) water systems are tending to become county or area-wide; (2) an increasingly larger fraction of total county population is being served by municipal water supply systems; (3) as systems become larger, larger and more dependable sources of supply are sought; and (4) the source becomes increasingly more remote from the point of use.

The seven-county area shown in table 5-1 includes the primary Appalachian Growth Centers of Spartanburg, and Gaffney, South Carolina, and secondary centers of Rutherfordton, Spindale, and Forest City, North Carolina. A close-up of this area is shown in exhibit 5-2; the area consists of Polk, Rutherford, and Cleveland Counties in North Carolina, and York, Spartanburg, Cherokee, and Union Counties in South Carolina, all arrayed along the I-85 Highway growth corridor. The South Carolina counties have experienced rapid economic growth in the last decade, and the North Carolina counties are beginning to show similar tendencies.

Water use for the seven-county area was estimated, utilizing the per capita rate for municipal uses presented in the Southeast River Basin Report and the water use vectors for industry utilized by FWPCA in Appendix D of this report. The rationale for diverging from FWPCA's estimates is that their rates for municipal use represent an average for all of the Appalachia area, whereas the Southeast River Basin Report values are considered to be more representative for this portion of Appalachia. The results of this estimate given in table 5-1 indicate water use of about 933 mgd by 2020, an increase in excess of 800 mgd over estimated use in 1960. While the essential values are net needs over available supply, this level of increase is indicative of the emerging economic growth for this Piedmont region.

Several studies of net water needs have been undertaken for this area, and an overall study of needs and the means for storage and conveyance are recommended for the area in this report and in Water Sub-region D report of the Appalachian Water Resources Survey (Chapters 7 and 8, Part II, Volume 4). The FWPCA indicates: a net need of about 140 mgd from the Clinchfield Reservoir; 112 mgd for the Spartanburg area and 28 mgd for downstream areas (see Appendix D). An analysis of growth center needs, which could possibly be served from the Clinchfield Reservoir indicates net needs of about 297 mgd for the Greenville-Spartanburg-Easley growth area - an area expected to

utilize a gross use of 804 mgd in 2020 (see table 5-2). Both Spartanburg and Greenville are actively seeking sources of 100 mgd each at the present time. The Keowee-Toxaway project of Duke Power Company appears to be a favorable alternative for supplying needs for the City of Greenville and the western side of Greenville County, while Clinchfield Reservoir appears to be a favorable alternative for Spartanburg County and perhaps the eastern side of Greenville County. Current studies indicate comparable first costs of distribution facilities from Clinchfield or Keowee-Toxaway to Greenville, but some advantages in pumping costs to the Keowee-Toxaway source. The requested future study will evaluate these sources more definitively.

TABLE 5-1

PROJECTED SEVEN-COUNTY WATER DEMAND (1)

		DEMAND ON MUNICIPAL WTR SUPPLY SYS.				Self-Supplied	
Year	Area BM Population(2)	Daily Consumption (gpcd)	Total	Domestic (x0.75)	Industrial (x0.25)	Industrial Demand(3) (mgd)	Total Demand (mgd)
1960	239,292	147	35.2	26.4	8.8	65.5	100.7
1980	385,249	170	65.5	49.1	16.4	152.1	217.6
2000	688,491	200	137.7	103.3	34.4	334.7	472.4
2020	1,048,870	217	227.6	170.7	56.9	705.0	932.6

(1) Counties: N. C. - Rutherford, Polk, Cleveland; S. C. - Spartanburg, Union, Cherokee, and York.

(2) Population served by municipal water supply systems.

(3) About 92% of this amount is expected to be supplied from surface sources; this is about 90% of total industrial demand. Employed are about 40% of total population; manufacturing employment about 43% of employed; total industrial water demand (mgd/manufacturing employee) amounts to about 0.00102, 0.001615, 0.0023 and 0.00327 in years 1960, 1980, and 2020, respectively, using the method for computing manufacturing water use shown in Appendix D (FWPCA), 2nd Draft, pages D-8 through D-12.

TABLE 5-2

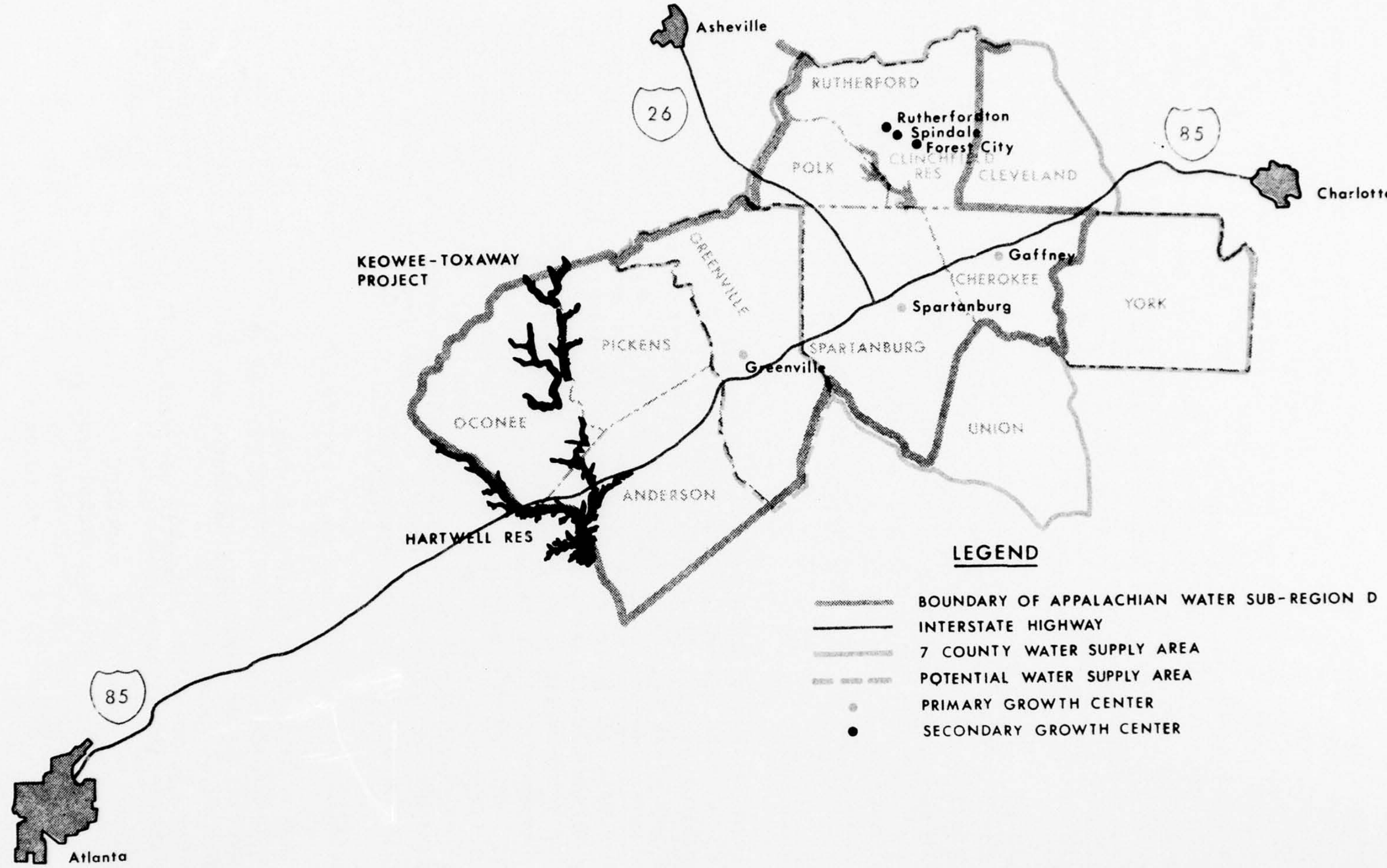
PROJECTED WATER DEMAND - GREENVILLE AND SPARTANBURG COUNTIES, S.C.

Year	Area BM Population (1)	DEMAND ON MUNICIPAL WATER SUPPLY SYSTEMS: Daily Consumption (gpcd)	DEMAND ON MUNICIPAL WATER SUPPLY SYSTEMS: Demand (2) (mgd)	Manufacturing Employment	Self-Supplied Industrial Demand (3) (mgd)	Total Demand (mgd)
			GREENVILLE			
1960	174,534	147	25.7	31,404	28.8	54.5
1980	260,195	170	44.2	45,877	66.7	110.9
2000	459,057	200	91.8	68,662	142.1	233.9
2020	705,389	217	153.1	102,685	302.2	455.3
			SPARTANBURG			
1960	84,923	147	12.5	27,097	24.9	37.4
1980	149,157	170	25.4	39,589	37.8	63.2
2000	277,648	200	55.5	59,251	122.6	178.1
2020	453,113	217	98.3	88,611	260.8	359.1

(1) Population served by municipal water supply systems.

(2) About 75% of this for domestic use; about 25% industrial.

(3) About 92% of this amount expected to come from surface sources. This is about 90% of total industrial demand, which is obtained by multiplying manufacturing employment by values (of mgd/manufacturing employee) given in note 3, preceding table.



CLINCHFIELD RESERVOIR
WATER SERVICE AREA

EXHIBIT 5-2

Preliminary results of a study looking towards a comprehensive water supply system for Rutherfordton, Ruth, Spindale, Forest City, and several other communities in Rutherford County, North Carolina, indicate what is likely to happen. The projected demand of this system was about 37 mgd in the year 2015. The present sources on the Second Broad River and its tributaries were found inadequate in quantity. Two sites of withdrawal on the Broad River were investigated, and the Clinchfield Reservoir site had the lower indicated costs. Thus a relatively small increment of demand, coupled with the desire to construct larger systems, may result in a need for 37 mgd from Clinchfield Reservoir. This process is expected to be repeated in the case of other area-wide systems, and the Clinchfield project should aid in the solution of such problems at minimum cost.

There are concurrent investigations of water supply needs underway both in North and South Carolina. While neither study is complete, the State's position, based on their current studies, is that 443 mgd of water supply storage should be placed in the Clinchfield project, evenly divided between each state. Each state has furnished assurances for repayment of allocated costs and views Clinchfield as a viable source of water for areas both in and outside of the Appalachian portions of their state.

Water Quality

The Federal Water Pollution Control Administration (FWPCA) evaluated the needs for water quality control measures after secondary treatment in the Broad River Basin. The points of need were established to be the Pacolet River downstream from Spartanburg and the Broad River downstream from the confluence of the Pacolet River. Flow objectives were established which would maintain acceptable dissolved oxygen in the year 2020 for streams receiving treated municipal and industrial effluent. Appendix D (water quality and water supply) prepared by FWPCA, indicates seasonal flow requirements on the Pacolet River downstream from Spartanburg and on the Broad River near Parr, North Carolina. Table 5-9 in this report indicates the flow objective for the Broad River reach immediately downstream from the confluence of the Pacolet River. A minimum dependable flow of 2000 cfs during the month of July would satisfy water quality criteria for dissolved oxygen in the year 2020 on the Broad River.

Recreation

The Bureau of Outdoor Recreation (BOR) inventoried the existing recreation facilities and demand for recreation in the recreation market area surrounding Clinchfield project site. The BOR found that present recreational development consists of 16,000 acres of water area and over 180,000 acres of land within an hour's driving time, and concluded that the facilities of these areas could provide opportunities for 1.2 million

recreation activity days. The estimated gross demand for the four recreation activities selected for analysis - boating, camping, swimming, and picnicking - is expected to increase from 5.3 million activity days in 1960 to 31.6 million in 2020. Independent estimates of recreational supply and demand were made by Charleston District, Corps of Engineers, and results are summarized in paragraph 15, following. These, essentially, substantiate the BOR estimates. Hence, there is a need for additional recreational opportunity based on current as well as projected deficiencies in the supply.

6. ALTERNATIVES AVAILABLE FOR MEETING NEEDS

Alternate projects which would satisfy the identified needs were considered to determine the most feasible plan of development of the water resources of the Broad River Basin.

Structural

A number of alternate reservoir sites were evaluated as alternatives to the Clinchfield Reservoir project. The widely dispersed flooding damages are not efficiently reduced by levees. Channel improvement could be utilized judiciously but the degree of effective protection would be much lower.

The Clinchfield site is, by far, the least costly reservoir site offering control of a similar drainage area and approaching the yield capability of the site. Since storage for water supply and for low flow regulations for water quality control purposes is a significant purpose of the Clinchfield project, other sites were evaluated as potential alternatives for these purposes. A site near Fingerville, South Carolina, on the North Pacolet River could be developed to provide low flow augmentation sufficient to meet the water quality needs along the Pacolet and on the Broad Rivers. The Fingerville project appeared to be the most economical alternative to the Clinchfield project for water quality purposes and was utilized as the measure of benefits for maintaining water quality in the Broad River Basin. While the Fingerville site would provide additional recreation benefits, the project could supply only a very limited additional yield of water supply. The FWPCA also evaluated the cost of advanced waste treatment to maintain water quality and found these costs in excess of dilution from the Fingerville site.

Attention was given to the water supply needs of Greenville and Spartanburg. Greenville presently obtains its water from the upper reaches of the Saluda, but the yield of this stream cannot meet more than about 40 mgd of the county's additional needs. Diversion of water

from the Keowee-Toxaway project to Greenville was considered. The cost of conveyance facilities from Clinchfield or Keowee-Toxaway appear to be comparable, but pumping costs appear to be slightly lower from Keowee-Toxaway. Current studies funded by the South Carolina Appalachian Planning Commission indicate that eastern Greenville County can be economically served from Clinchfield.

A preliminary analysis was made to determine whether, for an incremental demand of 100 mgd, Spartanburg could obtain such supply more economically from sources other than the Clinchfield Reservoir. In general, this analysis indicated that total annual costs were about $73,000 less than those applying to the most practicable alternative candidate.

The most practical alternative storage site is near the town of Fingerville on the North Pacolet River. The annual costs of a reservoir at this site to supply the Spartanburg demand is estimated to be about $505,000; annual transmission costs (gravity feed) to the city's raw water reservoir would amount to about $121,000; making total annual costs amount to about $626,000. Similar annual reservoir and transmission costs from a single-purpose water supply reservoir at the Clinchfield site (with the same yield) are about $259,000 and $475,000, respectively; totaling $734,000. However, the actual annual reservoir costs that would confront Spartanburg would be the Clinchfield multiple-purpose project costs allocated to water supply. This allocation is about $344,000 for the entire supply (443 mgd), and about $78,000 for 100 mgd. Total annual costs of water from the multiple-purpose project are then about $553,000 ($78,000 + $475,000), which gives the Clinchfield project an annual cost advantage of about $73,000 ($626,000 - $553,000) over the Fingerville development.

There were no sites providing comparable yield on the First or Second Broad Rivers. Additional sites were evaluated along the main stem of the Broad River, particularly the practicability of a reservoir at a site upstream of the existing Gaston Shoals Dam and about five miles south of the North Carolina State line, which had been previously evaluated along with other Broad River projects, in the so-called "308" studies of the early 1930's. This project, termed "Greater Gaston Shoals," offers a site having 30 percent less capacity than Clinchfield, and would require expensive relocation of a part of Interstate 85 highway. Average costs for storage in the alternate sites were higher, and additional water transmission costs could be anticipated. None of the alternate sites appear to approach the recreational potential of the Clinchfield site. Other considerations were the desirability that water projects considered under this authority should contribute substantially to the economic stimulation of the Appalachian Region, which favors a project relatively deep into the Appalachian Region. The Clinchfield Reservoir provides a large water surface, in combination with scenic land resources, along with excellent access to Interstate Routes 26 and

85. Thus it has the capability for filling a wide range of regional water needs more economically than any alternate project considered.

Non-Structural

Non-structural measures for reducing flooding damages, including flood plain zoning, appear to be most effective in urban areas which have alternate upland sites to develop and are not considered to be relevant measures for reducing agricultural crop and non-crop losses.

Water-saving devices and technology have been assumed to reduce water use over time, since the increases in projected water use per employee is less than the increases in the projected output per employee. Further reductions may be possible and practical, although the costs for providing beneficial supplies of good water appear to be nominal and unlikely to encourage the adoption of water-saving devices and processes for water cost saving reasons only. Provision of outdoor recreation opportunities by non-structural measures would be meeting an additional need rather than replacing the kind of opportunities which the reservoir and accompanying land development would provide.

Scale of Selected Project

The Clinchfield project was scaled to meet the broad range of regional water needs implied in previous paragraphs. The selected site has the physical and economic attributes which encourage full development of the site. Estimates at three levels of development were developed. The lowest level of development considered would total 5.07 inches of storage, would meet the water quality needs along the Broad River, and would provide 227 mgd of water supply and recreation. The highest level of development considered was the selected project,which would meet the water quality needs on the Broad River and provide 443 mgd of water supply, recreation, and flood control controlling the standard project flood event. A project in between the low and high was evaluated, which would meet the water quality needs on the Broad River, provide 379 mgd of water supply, recreation, and flood control adequate to control the third largest flood of record. Table 5-3 summarizes the size, storage allocations, and benefits and cost of the evaluated levels of development. The selected scale would maximize the excess of user benefits over cost and it is considered to obtain the maximum excess of regional income benefits over total costs.

Basis for Selection of Proposed Project

The Clinchfield Reservoir project emerged from these analyses as the most efficient alternative for solution of the water resource problems of this area. Also, the interlocking effect whereby each feature of the project will, in fact, enhance the others is absent from any alternative solution consisting of a system of diverse, widely dispersed components.

TABLE 5-3

CLINCHFIELD RESERVOIR, N. C.
ESTIMATES OF COSTS AND USER BENEFITS FOR DAMS OF VARIOUS CAPACITIES

Reservoir Storage Inches	Reservoir Storage Ac.Ft.	Storage Allocation Purposes	Storage Allocation Ac. Ft. (1,000)	Annual Benefits ($1,000)	Proj.Inv.($1,000) First Costs	Proj.Inv.($1,000) Annual Charges	Benefits less Costs ($1,000)
5	154,500	WS	40	256			
		WQ	90	253			
		Rec	0	1,428			
		Total	130	1,937	25,295	1,045	892
18	545,400	FC	107	62			
		WS	324	880			
		WQ	90	253			
		Rec	0	2,436			
		Total	521	3,631	45,671	1,908	1,723
34	1,036,000	FC	206	90			
		WS	716	1,053			
		WQ	90	253			
		Rec	0	3,393			
		Total	1,012	4,789	59,702	2,457	2,332

7. SELECTED PROJECT

A multi-purpose reservoir at the Clinchfield site emerged from the formulation analyses as the most efficient solution of the identified water control problems of the area. The reservoir would be formed by an earth fill embankment, about 3,300 feet long, located at mile 130 on the Broad River. Principal features of the structure are depicted on exhibit 5-3. The location and configuration of the reservoir are shown on exhibit 5-1. Outflow would be controlled by a 300-foot spillway with ten 30 by 20-foot gates, and by two 20-foot diameter conduits, one of which has a multi-level intake structure for selective releases during periods of thermal stratification. The sediment trap efficiency of this impoundment should result in almost complete deposition of the sediment of the inflow, leaving a very clear outflow.

The 20,220-acre reservoir would be the nucleus of the project's recreation development, expected to serve nearly six million recreationists a year by 2000.

Although there are no other major reservoir projects in the Broad River Basin, Clinchfield Reservoir has the control capacity to reduce flood damages for many miles below the damsite. The flood control effectiveness will range from nearly complete protection below the dam to negligible flood reduction downstream near Columbia, as the ratio of the controlled drainage area to the uncontrolled area becomes smaller.

8. PROJECT CAPABILITY TO MEET NEEDS

The capability of the Clinchfield Reservoir, as finally sized, and the capabilities of other alternatives considered to meet the needs of designated Appalachian growth centers, is displayed in table 5-4.

The Clinchfield Reservoir was sized to develop fully the water resource potentialities of the site, in response to the expressed desires of the States of North Carolina and South Carolina. The conservation storage (806,000 acre-feet, or 26.47 inches) is adequate to meet the foreseeable water supply and water quality control needs at least to the year 2020, and achieves a high degree of beneficial use of the watershed's runoff. The project provides storage to accommodate the standard project flood.

TABLE 5-4

EFFECTIVENESS OF ALTERNATIVES CONSIDERED IN
BROAD AND SALUDA RIVER BASINS, SUB-REGION D

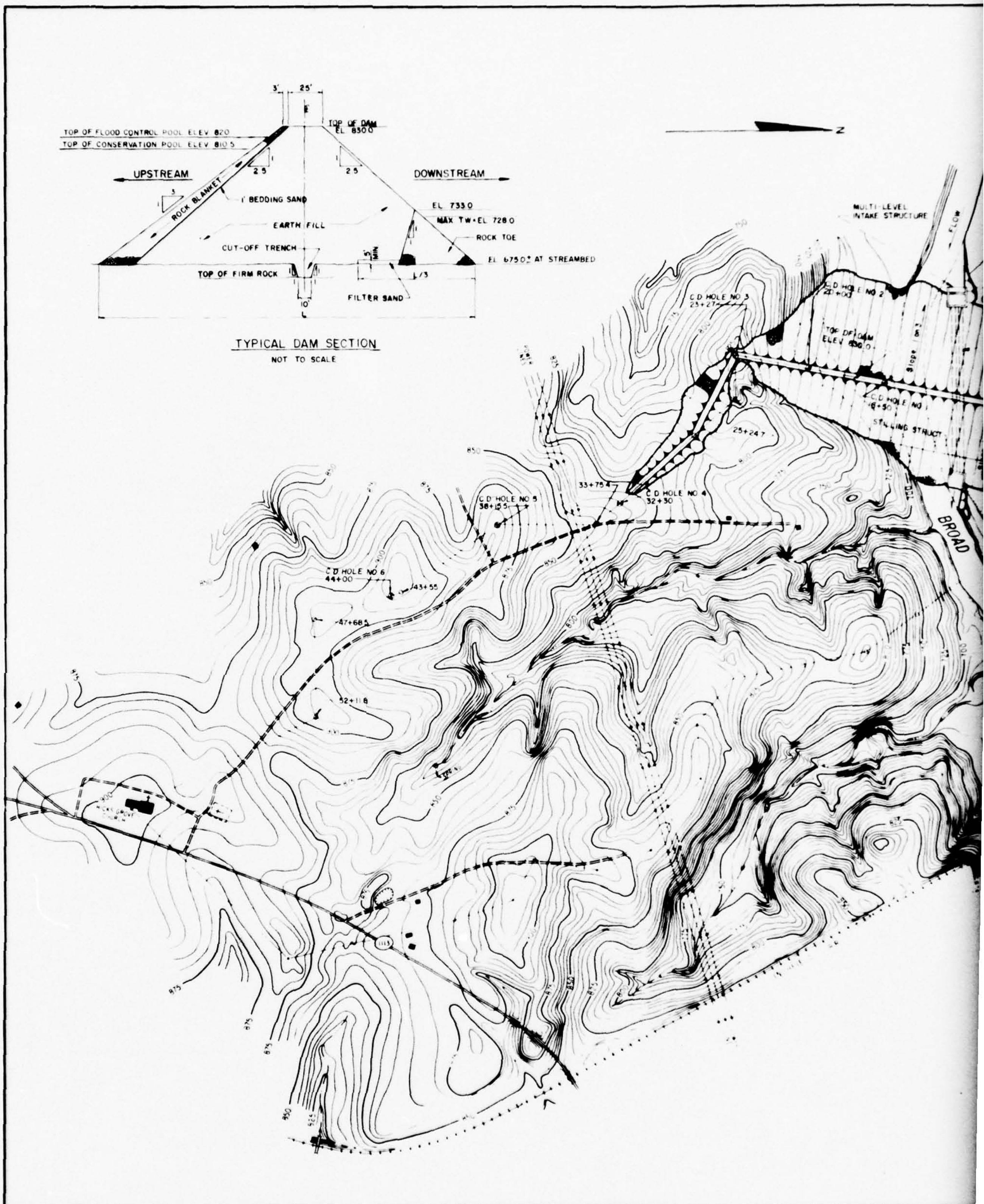
ITEM	NEEDS	Clinchfield Res. (CE)	South Pacolet River WS (USDA)	N. & Middle Tyger River WS (USDA)	Cherokee Cr. WS (USDA)	UNMET NEEDS	INDICATED FUTURE STUDIES
		OUTPUT OF ALTERNATIVE PROJECTS					
Water Supply	(mgd)						
Gaffney, S.C.	6	--	--	--	6	--	Source at Keowee-Toxaway
Easley-Greenville-Spartanburg, S.C.	291	443	12	--	--	--	Conveyance facilities, incl alternative
Water Quality	(1000 AF)						
Rutherfordton-Spindale-Forest City, N.C.	9	--	--	--	--	9	
Gaffney, S.C.	6	6	--	--	--	0	
Easley-Greenville-Spartanburg, S.C.	132	90	--	--	--	42	Compre. Survey of Upper Saluda Rvr. Basin
Flood Control (Current damage)	($1000)						
Rutherfordton-Spindale-Forest City, N.C.	5	--	--	--	--	5	Small Fl. Con. Proj., Flood Plain Mgt.
Gaffney, S.C.	12	--	--	--	4	8	Small Fl. Con. Proj. Flood Plain Mgt.
Easley-Greenville-Spartanburg, S.C	76[a/]	--	14	25	--	37[b/]	
Flood Control (Future urban land use in flood plain - acres							
Rutherfordton-Spindale-Forest City, N.C.	290	--	--	--	--	290	Small Fl. Con. Proj., Flood Plain Mgt.
Gaffney, S.C.	60	--	--	--	--	60	Small Fl. Con. Proj., Flood Plain Mgt.
Easley-Greenville-Spartanburg, S.C.	1,560	--	--	--	--	1,560	Recon. Rpt. at Spartanburg; Fl. Pl. Mgt.
Recreation Days (1000's)	19,300	5,700	105	92	16	13,387	Upper Saluda River Basin Study
Power (Peak demand, Gigawatts)	13.22	--	--	--	--	13.22	
Performance Index #1[c/]		2.1	1.8	1.2	2.8		
Performance Index #2[d/]		6.0	2.0	1.3	2.8		

a/ Assuming Reedy River Project is Implemented.

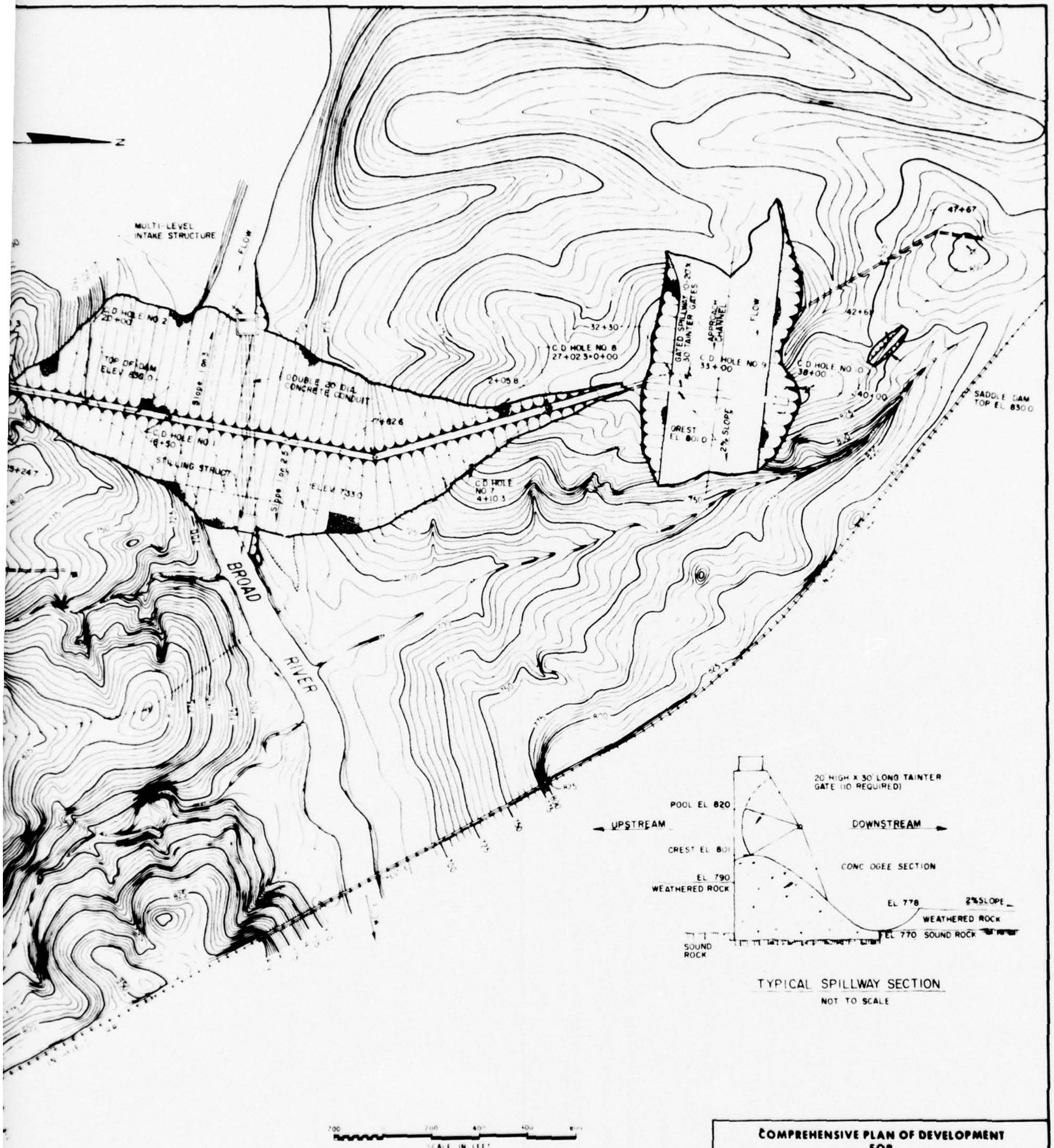
b/ Reconnaissance Report at Spartanburg;
Upper Saluda River Basin Study
Flood Plain Management, particularly along Reedy River at Greenville.

c/ (User and Redevelopment Benefits)/ (Project Costs)

d/ (Regional Income Gains)/ (Total Costs)


3'
25'
TOP OF DAM EL 830.0
TOP OF FLOOD CONTROL POOL ELEV 820
TOP OF CONSERVATION POOL ELEV 810.5
UPSTREAM
DOWNSTREAM
2.5
2.5
ROCK BLANKET
1' BEDDING SAND
EL 733.0
MAX TW EL 728.0
EARTH FILL
ROCK TOE
CUT-OFF TRENCH
5' MIN
EL 675.0± AT STREAMBED
TOP OF FIRM ROCK
L/3
FILTER SAND
10'
L
TYPICAL DAM SECTION
NOT TO SCALE
MULTI-LEVEL INTAKE STRUCTURE
FLOW
C.D. HOLE NO 3
23+27
C.D. HOLE NO 2
20+00
TOP OF DAM ELEV 830.0
C.D. HOLE NO 1
16+50
STILLING STRUCT
25+24.7
33+75
C.D. HOLE NO 4
32+30
C.D. HOLE NO 5
38+15.5
C.D. HOLE NO 6
44+00
43+55
47+68.5
52+11.8
BROAD
850
875

2



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD DAM SITE
PLAN & SECTIONS

BROAD RIVER, NORTH CAROLINA
SCALE
AS SHOWN

Drawn by WTJ GLWS
Checked by JER
Approved:
Title: District Engineer, Charleston District
Date: JANUARY 1968

 EXHIBIT 5-3

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SECTION III - DESIGN CONSIDERATIONS

9. INTRODUCTION

The adequacy of the project to accomplish its intended purposes and assure structural integrity is dependent on detailed economic analyses to determine its economic feasibility, hydrologic analyses to establish the storage and structural requirements, and geologic investigations of surface and subsurface site conditions and construction materials.

After considering these design data which established the project dimensions and structural features, real estate acquisition and relocation and modification of affected transportation and utility facilities were estimated in accordance with appropriate criteria. Anticipated demands for outdoor recreation opportunities, in excess of the capability of existing facilities, were the basis for evolvement of the initial recreation development in suitable areas adjacent to the reservoir.

10. HYDROLOGIC

The hydrologic factors which influence development of the reservoir plan include climatology, runoff, and the hypothetical spillway design flood.

General Climatology

The upper Broad River Basin has a mild climate. The growing season averages about 210 days. Climatological records are accumulated and published by the U. S. Weather Bureau of the Environmental Science Services Administration.

Temperature

Average temperature is about 58 degrees Fahrenheit, varying from 40 degrees in January to 75 degrees in July. Summers are warm and winters mild. Although freezing temperatures occur about 80 days each winter, zero temperatures are very rare. Summer temperature of 90 degrees or more average about 20 days, but 100-degree temperatures are very rare.

Rainfall

Rainfall over the basin averages about 54 inches per year. Seasonal distribution is favorable for crop production and other uses, ranging from about 2.5 inches to nearly five inches for the driest and wettest normal monthly values. Although there is mountainous ter-rain in the headwaters snowfall is not heavy enough to be a serious flood factor and periodic mild temperatures throughout the winter season preclude significant accumulations.

Storms

The most severe general storms which impinge on this basin are those of tropical origin, usually hurricane-spawned and occurring in late summer or autumn months. Extra-tropical storms occur more frequently and are often more intense, although usually highly localized, and may happen in either warm or cold months.

Major Storms of Basin

Numerous storms of the region have been analyzed in the preparation of the Corps of Engineers' Report entitled: "Storm Rainfall in the United States, Depth-Area-Duration Data." Although earlier major storms unquestionably occurred, records suitable for analysis either do not exist or are so fragmentary as to be useless for this purpose. The following tabulation presents data for storm areas of 500 square miles for the major storms analyzed.

Storm	Location of Center	Depth in inches 24 hours	Depth in inches 48 hours	Total Storm
13-17 Jul 1916	Altapass, N.C.	16.6"	19.5"	23.8"
10-17 Aug 1940	*Swansboro, N.C.	6.6"	8.6"	19.6"
23-28 Aug 1908	Vade Mecum, N.C.	9.9"	13.2"	18.0"
13-18 Sep 1945	Rockingham, N.C.	9.0"	10.3"	14.8"
13-17 Aug 1928	Caesars Head, S.C.	10.1"	11.2"	13.5"
13-16 Oct 1914	Mt. Mitchell, N.C.	8.6"	9.7"	12.7"

*Three other major centers located in Va., N.C., and S.C.

Droughts

Droughts, the antitheses of storms, must be analyzed in project formulation to establish storage requirements of a reservoir project. Drought frequencies and severities were studied to assure dependability of the conservation storage's capability to furnish sufficient water for identified water supply and water quality control needs.

Although both precipitation and streamflow records are dependable indicators of precipitation aberrations, the lengthy record at climatological stations would obviously be preferrable for analytical use to establish a drought frequency relation. The rainfall data at Charlotte, North Carolina, about 60 miles east of the damsite, cover the period from 1879 to date. The procedure followed was to divide the annual rainfall totals into 17 five-year groups, then to determine the minimum rainfall in each five-year group for selected durations and tabulate for each the minimum annual rainfall, and for multiyear durations

the average annual rainfall. Even though drought periods of less than a year's duration are frequently critical for reservoirs controlling smaller areas, the conservation storage of the proposed Clinchfield Reservoir is obviously great enough that more severe short-term droughts would not endanger the supplies. Normal rainfall at Charlotte, as of 1966, is 43.38 inches. Table 5-5 presents the frequency and average value for one and five-year durations for the five most severe deficiencies at the Charlotte station.

Streamflow deficiency was also investigated at Broad River near Boiling Springs. Since the streamgaging station is located six miles downstream from the Clinchfield damsite, its record would be indicative of drought conditions that could be expected to occur at Clinchfield. The procedure followed was to group the flows into two-year intervals and the minimum flows for durations of one, three, six, and twelve months were determined and their frequency statistics computed and plotted. Techniques employed for determining flow and rainfall frequencies were, using in part, procedures and methods presented in Leo R. Beard's "Statistical Methods in Hydrology." Estimated recurrence intervals for the five lowest flows and durations of one and 12 months are given in Table 5-6. Based on rainfall, the most severe short-term drought occurred in 1925 when an annual rainfall of 29.71 inches was recorded. Using streamflow data, the lowest flow for a one-month duration and a 12-month duration occurred in the 1954-1955 period. This is the same period as for the long-term drought. Applying unit area values to the one-month duration flow of 237 cfs and the 12-month duration flow of 710 cfs, corresponding equivalent flows for Clinchfield Reservoir would be 157 cfs and 470 cfs, respectively.

Initial Losses and Infiltration

Concurrent analyses of suitable precipitation and streamflow records were made to determine the rainfall volume above the streamgaging station, its areal and temporal distribution, the rainfall excess (equivalent to the runoff volume from the effective storm area), and the rainfall losses (normally limited to initial loss and infiltration capacity). Based on these studies initial losses were found to vary from about 0.5 inch to 1.5 inches, depending upon antecedent rainfall and development of vegetative growth which is largely seasonal. Infiltration capacities were widely variant, from about 0.05 to 0.50 inch per hour. Discarding the outlier results, 0.10 to 0.15 inch per hour was found to be the usual range of minimum rates.

Streamflow

Records of streamflow are acquired and published by the U. S. Geological Survey (USGS). Publications of the USGS also furnish data on water quality, groundwater, and magnitude and frequency of floods.

TABLE 5-5
FREQUENCY - PRECIPITATION DATA FOR DROUGHTS OF RECORD

Rank of Severity	1	2	3	4	5
Item	Period of Record: 1879-1966				
	17 5-Year Periods				
	One-Year Duration (Skew = 0.8)				
5-Year Period	1924-28	1929-33	1949-53	1939-43	1959-63
Frequency*	1.1	1.4	21.0	22.0	31.0
Precipitation	29.71	29.88	33.46	33.63	34.71
	Five-Year Duration (Skew = 1.6)				
5-Year Period	1949-53	1954-58	1894-98	1909-13	1914-18
Frequency*	0.8	2.0	9.0	11.0	16.0
Precipitation**	39.66	39.95	40.47	40.56	40.88

* Exceedence Frequency - Events Per Hundred Years
** Minimum Mean Annual Precipitation for Indicated Duration in Inches

TABLE 5-6
FREQUENCY - DISCHARGE DATA FOR DROUGHTS OF RECORD
USING TWO-YEAR INTERVALS
BROAD RIVER NR BOILING SPRINGS, N.C. (1926 - 1965)

	Order of Magnitude				
	1	2	3	4	5
	Mean Daily Flow in CFS for Durations Indicated				
20 Two-year periods					
One-Month Duration (Skew = -0.8)					
Years	1954-55	1956-57	1932-33	1926-27	1930-31
Frequency*	2.2	5.8	12.8	19.0	23.0
Discharge-cfs	237	295	362	405	426
Twelve-Month Duration (Skew = 0.0)					
Years	1954-55	1956-57	1926-27	1930-31	1940-41
Frequency*	2.3	5.2	10.0	13.5	24.5
Discharge-cfs	710	779	850	887	990

* Non-Exceedence Frequency per Hundred Years

Runoff

The average runoff from the Broad River watershed above the damsite is about 23 inches, or about 43 percent of the rainfall. Flows past the damsite average about 970 cfs and have varied from about 55,000 cfs (Aug. 1928) to minimums of 40 cfs or less as a result of diurnal fluctuations due to upstream powerplant operation. Except during sustained rainless periods, flows are adequate for most needs. Runoff data for selected streamgaging stations are given in Table 5-7.

TABLE 5-7

STREAM GAGING DATA FOR SELECTED STATIONS
CLINCHFIELD RESERVOIR, NORTH CAROLINA AND SOUTH CAROLINA

Stream and Station	Period of Record	Drainage Area Sq. mi.	Period of Record -Av.		Maximum of Record		Minimum of Record	
			cfs	inches	year	inches	year	inches
Second Broad River Cliffside, N.C.	1925-67	211.0	299	19.3	1965	32.1	1955	9.7
Broad River Boiling Springs, N.C.	1925-67	864.0	1438	22.6	1960	34.9	1956	12.3
Broad River Richtex, S.C.	1925-67	4850.0	6086	17.0	1960	26.3	1955	9.5
Pacolet River Clifton, S.C.	1939-67	320.0	495	21.0	1965	29.1	1941	11.4
Saluda River Pelzer, S.C.	1929-67	405.0	788	26.4	1949	42.2	1955	15.7

Floods

Floods may occur during any month of the year. The streams commonly have two highwater periods. The first, or major period, is from December to April, and the floods are caused by the winter and early spring rainstorms. The second period of highwater is from August to October and the floods are generally caused by the hurricane-type storms that come up the Atlantic Coast. The greatest number of floods occur during the first flood period from December to April; however, the most severe floods predominantly occur in the second period from August to October. No one flood produced the highest known stages in all portions of the

basin. In the Broad River watershed, the maximum floods of record were in August 1928, October 1929, and August 1940. The maximum and second largest floods for Broad River watershed at selected streamgaging stations are given in Table 5-8.

Inasmuch as there is no streamgaging station in the vicinity of the damsite, the analysis of floods was based on available records at nearby gages. The Broad River gaging station near Boiling Springs records flows from 864 square miles compared to 571 at the damsite. Hydrologic dissimilarities between this and adjacent watersheds preclude establishing a satisfactory flood frequency relationship based on other gaging stations.

Broad River index stations selected to evaluate the economic effects of flood control storage allocated to the Clinchfield Reservoir were: Gaffney, Carlisle, Richtex, and Columbia gaging stations. Frequency analyses for natural and regulated conditions at these stations were conducted using graphical and analytical procedures presented in the publication "Statistical Methods in Hydrology" by Leo R. Beard, Office of the Chief of Engineers, Department of the Army. Exhibit 5-4 illustrates flood control effects of Clinchfield Reservoir at the gaging station near Gaffney, South Carolina. Since the drainage area above the damsite is only about 38 percent of the total, this serves to illustrate the dimunition of the flood control effectiveness as the uncontrolled drainage area increases. Zero skew coefficients for these stations fit the normal population distribution adequately, except for the Gaffney station for which a skew of 0.8 was considered necessary to determine the frequency curve of best fit.

Flood Analyses and Unit Hydrograph Determination

The August 1940 storm and flood on Broad River near Boiling Springs, N.C., was selected for a unit hydrograph study. This flood was the second largest flood of record at the stream gaging station where a peak discharge of 60,400 cfs was recorded on 14 August. Runoff from the storm was 2.99 inches from the 864-square mile drainage area. A 12-hour natural unit hydrograph was derived from the storm study.

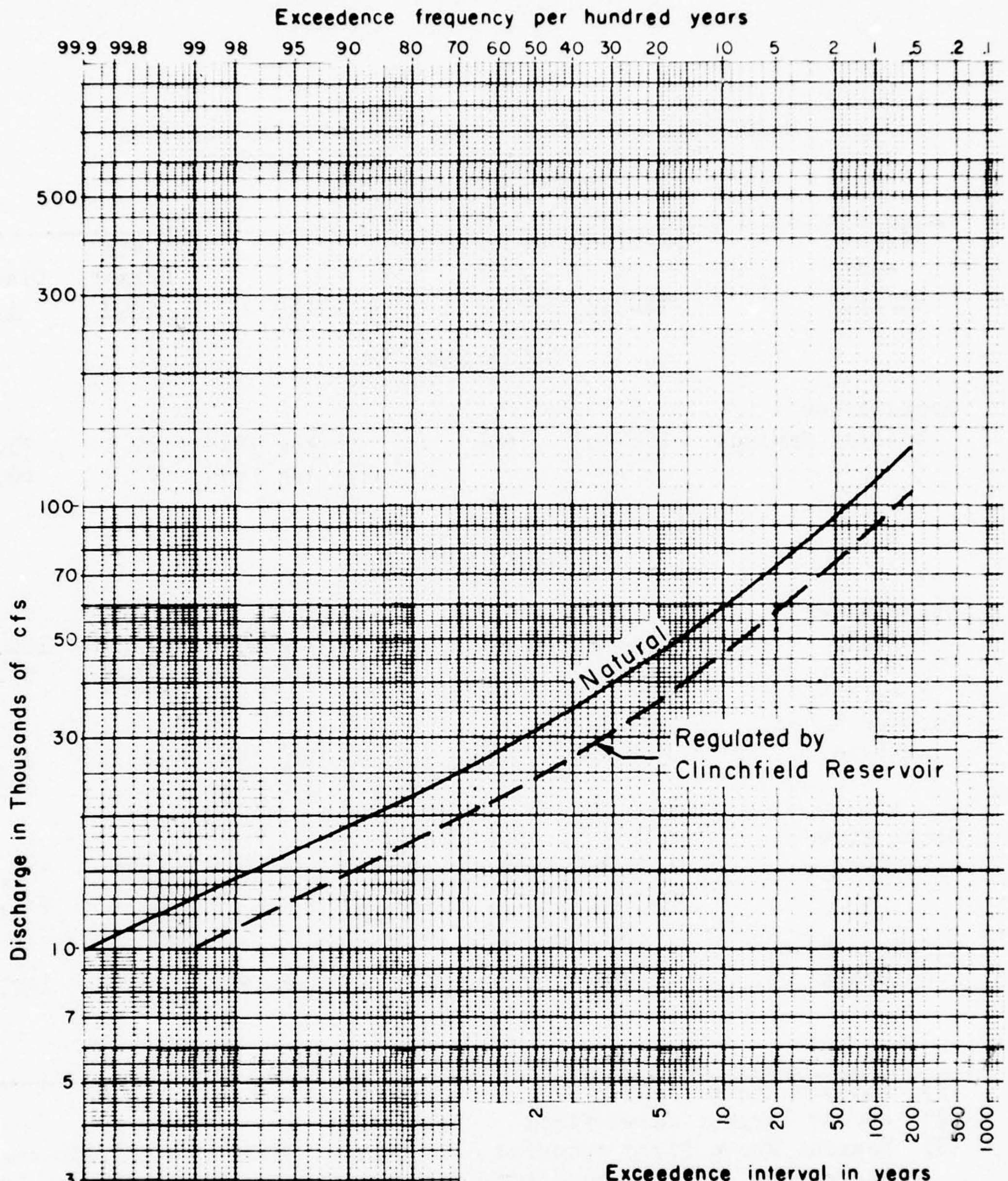
The unit hydrograph for Clinchfield Reservoir was prepared using guide procedures given in EM 1110-2-1405 and applicable relationships obtained from the natural 12-hour unit hydrograph described above. The watershed contributing to the Clinchfield Reservoir was divided into three land areas as follows: for the inflow points at upper reach of the reservoir, the Green River area (151 sq. mi.) and Broad River (109 sq. mi.) were used; and the area contributing directly to the reservoir (285 sq. mi.). Six-hour unit hydrographs were computed for these areas and combined to form a composite 6-hour unit hydrograph for Clinchfield Reservoir, as shown on exhibit 5-5. Rainfall on the 26-square mile static pool area would not be subject to the losses of the land areas

TABLE 5-8

MAJOR FLOOD IN BROAD RIVER FOR SELECTED STATIONS
CLINCHFIELD RESERVOIR, NORTH CAROLINA
AND SOUTH CAROLINA

Stream and Station	Period of Record	Drainage Area (sq.mi.)		Date	Gate Height (ft.)	Discharge (cfs)
		NORTH CAROLINA				
Broad River						
Boiling Springs	1925-67	864	(1)	16 Aug 1928	24.3	73,300
			(2)	14 Aug 1940	22.1	60,400
		SOUTH CAROLINA				
Broad River						
Gaffney	1938-67	1490	(1)	14 Aug 1940	19.78	119,000
			(2)	6 Oct 1964	15.61	67,100
Pacolet River						
Clifton	1939-67	320	(1)	14 Aug 1940	21.19	26,800
			(2)	5 Oct 1964	17.31	20,100
Broad River						
Richtex	1925-67	4850	(1)	3 Oct 1929	30.7	228,000
			(2)	17 Aug 1928	30.1	222,000
Congaree River						
Columbia	1939-67	7850	(3)	10 Apr 1964	28.60	142,000

(1) Maximum known flood
(2) Second largest known flood
(3) Maximum known flood occurred 27 Aug 1908, discharge 364,000 cfs, stage 39.8 feet. Second largest known flood occurred 18 Aug 1928, discharge 311,000 cfs, stage 33.5 ft. Flow regulated by Lake Murray on Saluda River since Aug 1929.



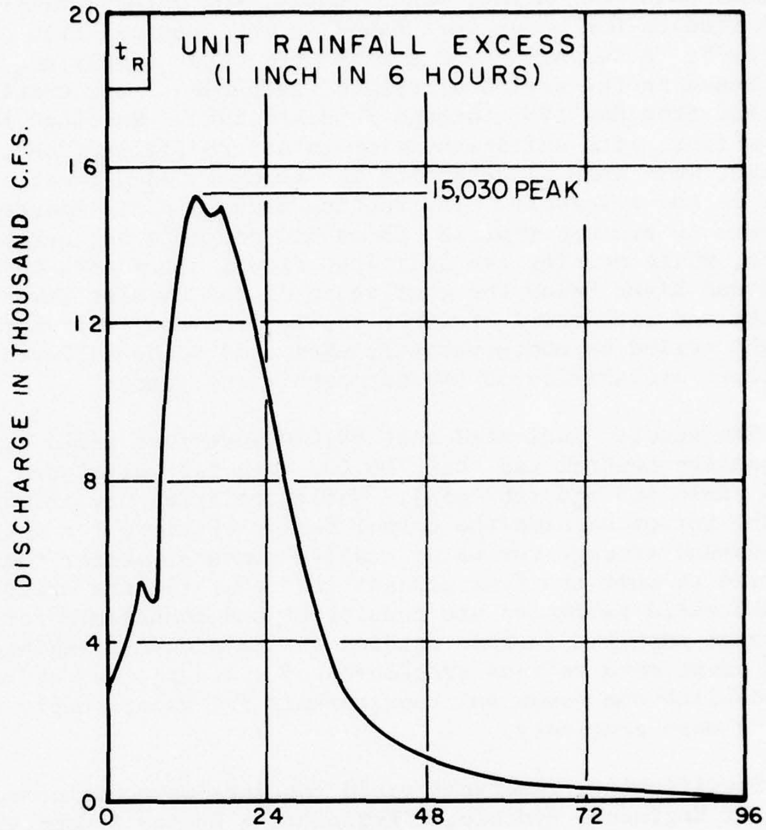
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

PEAK DISCHARGE FREQUENCY CURVES
BROAD RIVER Nr GAFFNEY

SCALE
AS SHOWN

Drawn by: W. H. D.
Checked by: J. F. R.
Approved:
Title: Chief, Proj. Plan. Br.
Date: February 1968

EXHIBIT 5-4



TIME IN HOURS

(6 HOUR UNIT HYDROGRAPH)

NOTE

Does not include slight increase in runoff that would occur with the reservoir in place.

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

UNIT HYDROGRAPH

CLINCHFIELD RESERVOIR

SCALE

AS SCALE

Drawn by: W. H. D

Checked by: J. F. R.

Approved:

Title: Chief, Proj. Plan. Br.

Date: February 1968

EXHIBIT 5-5

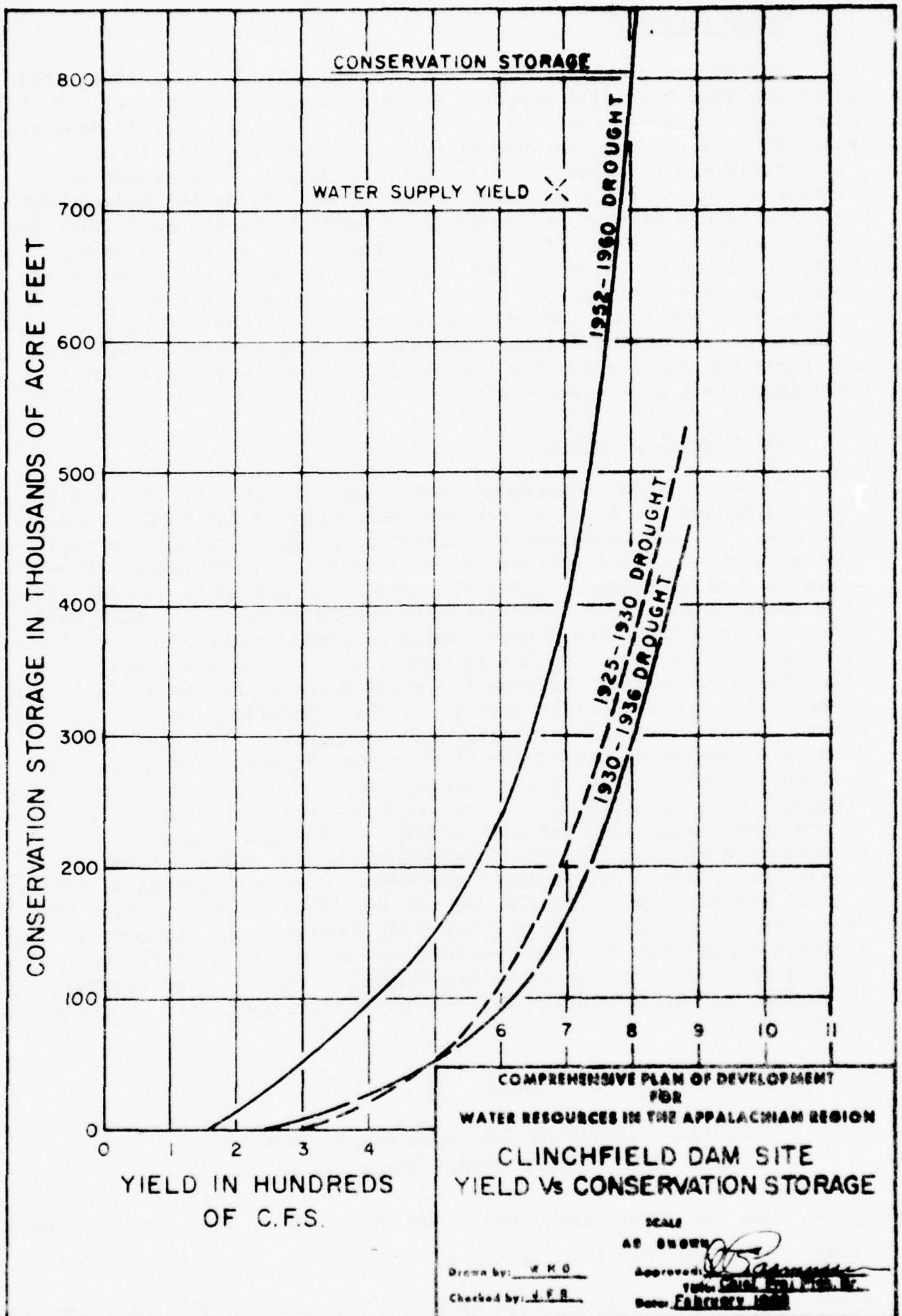
and is considered to be 100 percent effective in increasing the reservoir storage.

Conservation Storage vs. Yield

Reservoir yield studies were made for the Clinchfield Project to evaluate power potential, water supply, and water quality. Reservoir yield studies for power were based on the critical flow period of record 1954-1958. Reservoir yield studies for water supply and water quality were based on the period of record, 1925-1966. The critical drought period occurred from May 1952 through February 1960. Routings for the periods of low flow, with sufficient time to assure filling the conservation storage, were made to determine the recommended allocation of storage space in the reservoir. The routing assumed a minimum reservoir release adequate to protect riparian flows and computed net evaporation losses, while meeting the indicated flow requirements in the reach of the Broad River below the confluence of the Pacolet River for water quality and withdrawal of water supply from the reservoir. The critical drought period is conservatively estimated to be a 50-year drought or a failure probability of two percent in any year.

The studies indicated that 90,000 acre-feet would be needed for water quality control and that 716,000 acre-feet allocated to water supply would yield 443 mgd (687 cfs). While the frequency of the critical drought period exceeds the normal design criteria for water quality, and the adopted storage for water quality somewhat larger than would be required to meet the five percent chance of failure criteria, the storage and yield estimates are consistent and comparable for water quality and water supply. Further studies during advanced engineering and design could adopt more refined procedures of synthetic and hydrologic records to establish the needs and requirements for water supply and water quality more precisely.

Specifically, reservoir yield routings were performed using the Corps of Engineers Hydrologic Engineering Center's Computer Program No. 23-J2-L245, entitled "Reservoir Yield." Reservoir inflows, used in the routings, were computed for the period 1925 to 1966. Net reservoir losses under post-project conditions were estimated by assuming that reservoir evaporation rates would be 70 percent of pan evaporation rates and that post-project increases in runoff from that part of the watershed inundated by the reservoir would be about 55 percent. Minimum releases at the reservoir were set at 50 cfs which was about the minimum monthly flow that occurred during the period of record. No seasonal variations were considered in the routings for water supply demands but were considered in connection with water quality control. Seasonal requirements for water quality control were furnished by the Federal Water Pollution Control Administration (FWPCA) for critical reaches along the Broad River and its tributaries. Clinchfield storage allocations for various purposes are discussed below. Yield obtainable from various storage allocations is shown on exhibit 5-6.


CONSERVATION STORAGE
WATER SUPPLY YIELD
1952-1960 DROUGHT
1925-1930 DROUGHT
1930-1936 DROUGHT
CONSERVATION STORAGE IN THOUSANDS OF ACRE FEET
0
100
200
300
400
500
600
700
800
0
1
2
3
4
6
7
8
9
10
11
YIELD IN HUNDREDS OF C.F.S.
COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION
CLINCHFIELD DAM SITE
YIELD Vs CONSERVATION STORAGE
SCALE AS SHOWN
Drawn by: W K G
Checked by: J F B
Approved:
Title: Chief Eng. Plan. Br.
Date: February

Water Supply

The States of North Carolina and South Carolina have given their assurance that they will support, and find utilization for, all of the water supply storage that can be developed in the Clinchfield Reservoir. Based on this premise, storage allocated for water supply in the Clinchfield project amounts to 716,000 acre-feet. This amount of storage would provide a sustained yield of 687 cfs or 443 mgd through the most severe drought of record (1952-1960). The 443 mgd yield that would be provided from Clinchfield, therefore, is likely to be the cheapest source of water to meet the future needs of the seven-county area. To fully utilize this amount of water supply storage, it will be necessary to construct extensive water supply systems encompassing whole counties or several counties. This will require a joint effort from all those who are responsible for obtaining and distributing water throughout this seven-county area.

Water Quality Control

The streamflow requirements necessary for water quality control of the Pacolet and the Broad Rivers were furnished by the FWPCA. These are the flows required to maintain a dissolved oxygen level of 4.0 mg/l. The most economical method of control water quality on the Pacolet River would be a single-purpose reservoir located on the North Pacolet River near Fingerville, S. C. The next best method would be advanced waste treatment; and the third method, would be piping wastes from Spartanburg, S. C. to Broad River. The latter method would require storage in the Clinchfield Project to clean-up the Broad River below the outfall of the piped wastes. The required storage in the Clinchfield Project to control water quality was based on piping Spartanburg wastes to Broad River. Thus, the storage allocated for this purpose amounts to 90,000 acre-feet which would provide enough storage for the estimated 50-year drought. This quantity was determined from reservoir yield routings as previously discussed and will provide sufficient storage to maintain the minimum flow requirements set by the FWPCA during any drought of record. The required streamflow necessary for water quality control are based on estimates for the year 2020. Releases from the reservoir for water quality are based on supplementing streamflow only at those times when the uncontrolled area streamflow is deficient in meeting the needs for water quality control. The required seasonal streamflow for water quality for the Broad River near Parr is given in Table 5-9.

TABLE 5-9

REQUIRED STREAMFLOW FOR WATER QUALITY CONTROL
BROAD RIVER NEAR PARR, S.C.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(cfs)	1550	1530	1670	1810	1910	1970	2000	1980	1930	1870	1800	1700

Storage required in Clinchfield Reservoir to maintain 2020 flows during the critical 50-year drought - 90,000 acre-feet.

Low Flow Releases

Hypothetical reservoir routings were performed by an electronic computer for Clinchfield Reservoir as previously discussed. Inflows and net reservoir losses for the critical drought periods were computed under post-project conditions. It was assumed that reservoir evaporation rates would be 70 percent of pan evaporation and post-project increases in runoff from the area of the reservoir would be about 55 percent. Minimum releases were set to maintain the minimum flow determined from available records. For Clinchfield Reservoir this value was 50 cfs. A minimum release of 50 cfs from the reservoir is considered adequate to satisfy reparian requirements for the six-mile reach downstream to the mouth of the Second Broad River which has a drainage area of 224 square miles. No seasonal variations were considered for water supply demands or yields. Seasonal requirements used in connection with quality control were furnished by the FWPCA for critical reaches along the Broad River and its tributaries. For Clinchfield Reservoir estimates of intervening area runoff were used in all routings for determination of conservation storage allocations and yields from various storage quantities.

Hydropower

Hydrologic studies for development of hydropower at Clinchfield assumed several conditions. All of the reservoir yield studies for power were based on the critical flow period of record 1954-1958. The assumptions of pertinent conditions which were favorable to production of hydroelectric power are listed as follows:

a. Power Project (single purpose).
b. Power and water supply demand 100 mgd (run through turbines with water supply intake downstream of reservoir).
c. Power and water quality for Broad River.
d. Power, water supply (same as b.) and water quality for Broad River.
e. Power and water supply demand 100 mgd (water supply taken directly from the reservoir to reduce pumping head).
f. Power, water supply (same as e.) and water quality for Broad River.

The reservoir yield studies for these six conditions were made with the top of power pool at elevation 820; - assuming a ten-foot drawdown, a 20-foot drawdown and the maximum drawdown for each condition with complete annual recovery of stage. For the 20-foot drawdown condition, these studies indicated installed capacities of 65,350 KW for condition a and b; and 65,180, 63,010, 50,640, and 48,400 KW for condition c through f, respectively. These values are based on using a plant factor of ten percent and an average tailwater elevation of 680 feet. Subsequent to these studies, it was determined that it was essential to provide a re-

regulating dam and afterbay which would require a tailwater higher than the 680 elevation. Consequently, installed capacities would be somewhat less than those given above.

Based on the utilization of a 59,000 KW capacity power plant for peaking purposes, the annual value of capacity and energy (total power benefits) amounted to about $777,550, while the total annual charges for specific power facilities (using a 3¼ percent interest rate) amounted to about $845,000. Since the value of the capacity and power was not sufficient to offset the cost of specific facilities for power, power features are omitted from the Clinchfield project.

Flood Control

Clinchfield Reservoir will provide 205,500 acre-feet of storage for the control of floods. This amount of storage will control all the floods of record and even the standard project flood at the damsite. The main stem flood plain of Broad River below Clinchfield to Columbia, S. C., is mostly rural. Crop lands in the flood plain are usually small isolated acreages while the majority of the farmland is used for pasture. There are 11 small communities located along the river which are subject to flooding in some degree. Broad River major and moderate floods cause considerable damage to crops and livestock, destruction and damage to mills, highways, railroads, bridges, towns, and farm buildings. Because of the past history of damaging floods on Broad River, it was considered desirable to provide storage in the Clinchfield Project which would control the standard project flood. Control of the standard project flood will alleviate flooding of the large downstream residual flood plain area. The flood control pool can be emptied in about one week, maintaining releases within channel capacity.

Sediment

There are no suspended sediment samples available for Broad River on which to base estimates of the quanitity of sediment load. Sediment deposition rates are available for two reservoirs located in the Broad River watershed which will give some indication of deposition rates for Clinchfield Reservoir. The sediment data for these two reservoirs are as follows:

Reservoir	Stream	Nearest Town	Drainage Area (sq. mi.)	Yrs of Record	Average Ann. Sediment Accumulation per sq. mi. (ac. ft.)
Spartanburg Municipal	South Pacolet River	Fingerville, S.C.	90.8	20.9	0.324
Appalachia	South Tyger River	Greer, S.C.	62.8	30	0.480

After consideration of sediment deposition records of other reservoirs in the general area, an average annual sediment rate of 0.55 acre-foot per square mile of drainage area was selected for the Clinchfield Project. The watershed above Clinchfield contains three existing reservoirs, namely: Lake Summit (drainage area 42 sq. mi.) and Lake Adger (drainage area 135 sq. mi.) which are located on Green River, and Lake Lure (drainage area 95 sq. mi.) located on Broad River. The assumption was made that these reservoirs would effectively control sediment production from their respective drainage areas during the first 50 years at Clinchfield and for the second 50 years they would no longer have any effect. Based on this premise, the estimated sediment deposition in Clinchfield Reservoir for the first 50 years would amount to 8,222 acre-feet (299 sq. mi. net drainage area) and for the second 50 years 15,703 acre-feet (571 sq. mi. net drainage area), totaling 23,925 acre-feet. The estimated 100-year sediment deposition in Clinchfield Reservoir is three percent of the storage allocated to conservation, therefore, sedimentation will have no significant effect on the life of the reservoir or allocation of storage for other purposes.

Area and Capacity

Maps available to determine the areas of Clinchfield Reservoir were the U. S. Geological Survey quadrangle maps: Cowpens prepared in 1959, contour interval of 20 feet; Inman prepared in 1961, contour interval of 20 feet; and Lake Lure prepared in 1959, contour interval of 40 feet. The three maps were drawn to a scale of 1:62,500. In addition, the USGS stereo-compilation prints for Rutherfordton, scale 1:24,000, and contour interval of 20 feet were available. All the maps were enlarged to a scale of 1:20,000 and the 20-foot contours were interpolated on the Lake Lure quadrangle. The areas at 20-foot intervals were then determined from the enlarged map and plotted. Capacities for the various pool elevations were computed from the area curve. The area and capacity curves for Clinchfield Reservoir are shown on exhibit 5-7.

Standard Project Flood

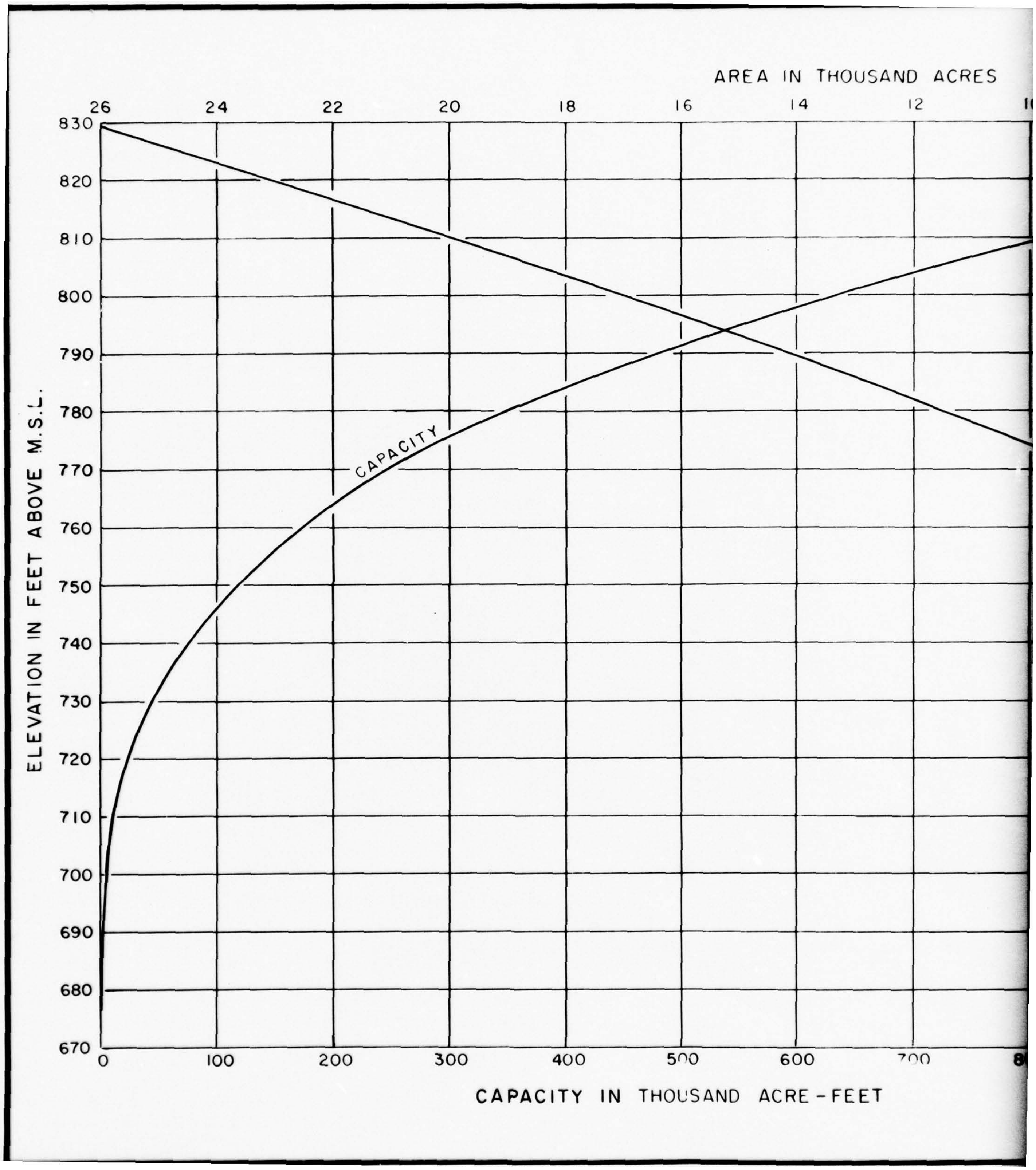
A standard project flood was developed for the Clinchfield Reservoir from generalized estimates of rainfall and procedures outlined in Civil Engineer Bulletin No. 52-8. Losses of 1.00 inch initially plus 0.13 inch per hour infiltration capacity were subtracted from the rainfall amounts. Rainfall excess amounts so obtained were applied to the six-hour unit hydrograph to obtain the flood hydrograph which includes direct rainfall falling on the reservoir area. The standard project flood for the reservoir has a peak of 122,500 cfs and a volume of 237,800 acre-feet, equivalent to 7.81 inches of runoff from the drainage area of 571 square miles. The hyetograph of the storm and the inflow hydrograph are shown on exhibit 5-8.

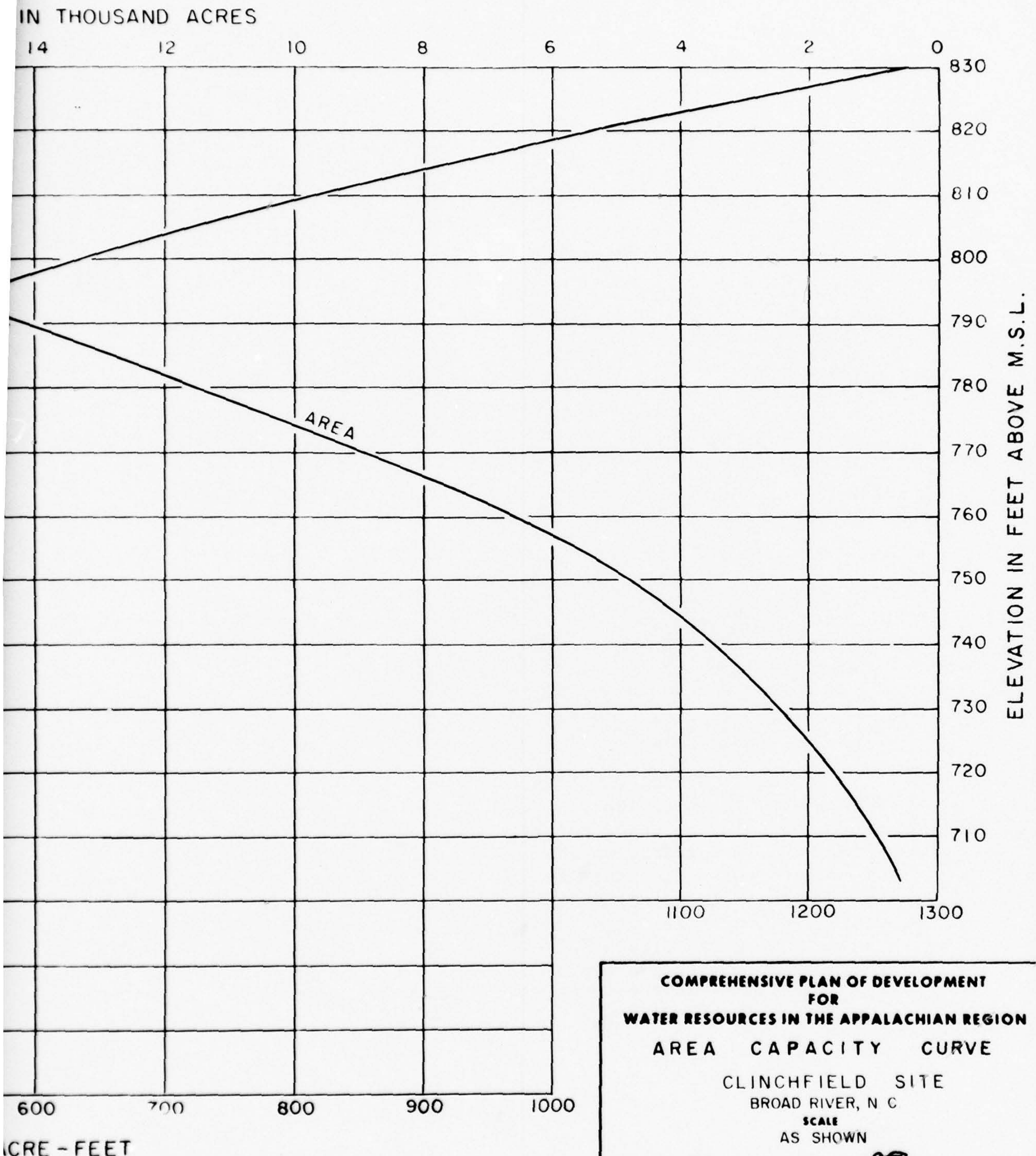
Spillway Design Flood

Probable maximum precipitation (PMP) estimates for Clinchfield Reservoir are based on the all-season generalized chart developed by the U. S. Weather Bureau in Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours." The PMP values obtained from the generalized charts were reduced ten percent to allow for basin shape as indicated in EC 1110-2-27. The PMP of 25.03 inches was determined for a storm of 48 hours duration. The six-hour rainfall values were computed and arranged in critical order of occurrence. Initial loss of 1.00 inch and an infiltration capacity of 0.13 inch per hour were subtracted from the six-hour rainfall to derive the rainfall excess for each period. Rainfall excess amounts so obtained were applied to the six-hour unit hydrograph to obtain the flood hydrograph. The spillway design flood for the reservoir has a peak of 270,600 cfs and a volume of 611,000 acre-feet, equivalent to 20.06 inches of runoff from the 571-square mile contributing drainage area, which includes total rainfall runoff from the large reservoir area. The hyetograph of the storm and the inflow hydrograph are shown on exhibit 5-9.

Spillway Width vs Embankment Height

A gated spillway would be provided for the passage of extremely large floods in order that the conservation pool be at as high a level as possible and maximum flood storage space be provided at the site. The spillway would be located in a saddle on the left bank of Broad River a short distance from the extreme end of the dam. The spillway channel would discharge into a ravine. The selection of the physical dimensions of the spillway is dictated to a large extent by the configuration of the site and its geology. Since the Clinchfield Project was developed to its physical capacity which limits the top of dam to elevation 830, it was not considered necessary to make extensive routings to determine the optimum spillway capacity.


AREA IN THOUSAND ACRES
26
24
22
20
18
16
14
12
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
ELEVATION IN FEET ABOVE M.S.L.
CAPACITY
0
100
200
300
400
500
600
700
CAPACITY IN THOUSAND ACRE-FEET



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

AREA CAPACITY CURVE

CLINCHFIELD SITE
BROAD RIVER, N. C.
SCALE
AS SHOWN

Drawn by: W.D.
Checked by: J.E.R.
Approved: [signature]
Title: Act Chief, Proj Plan Br
Date: JAN. 1968

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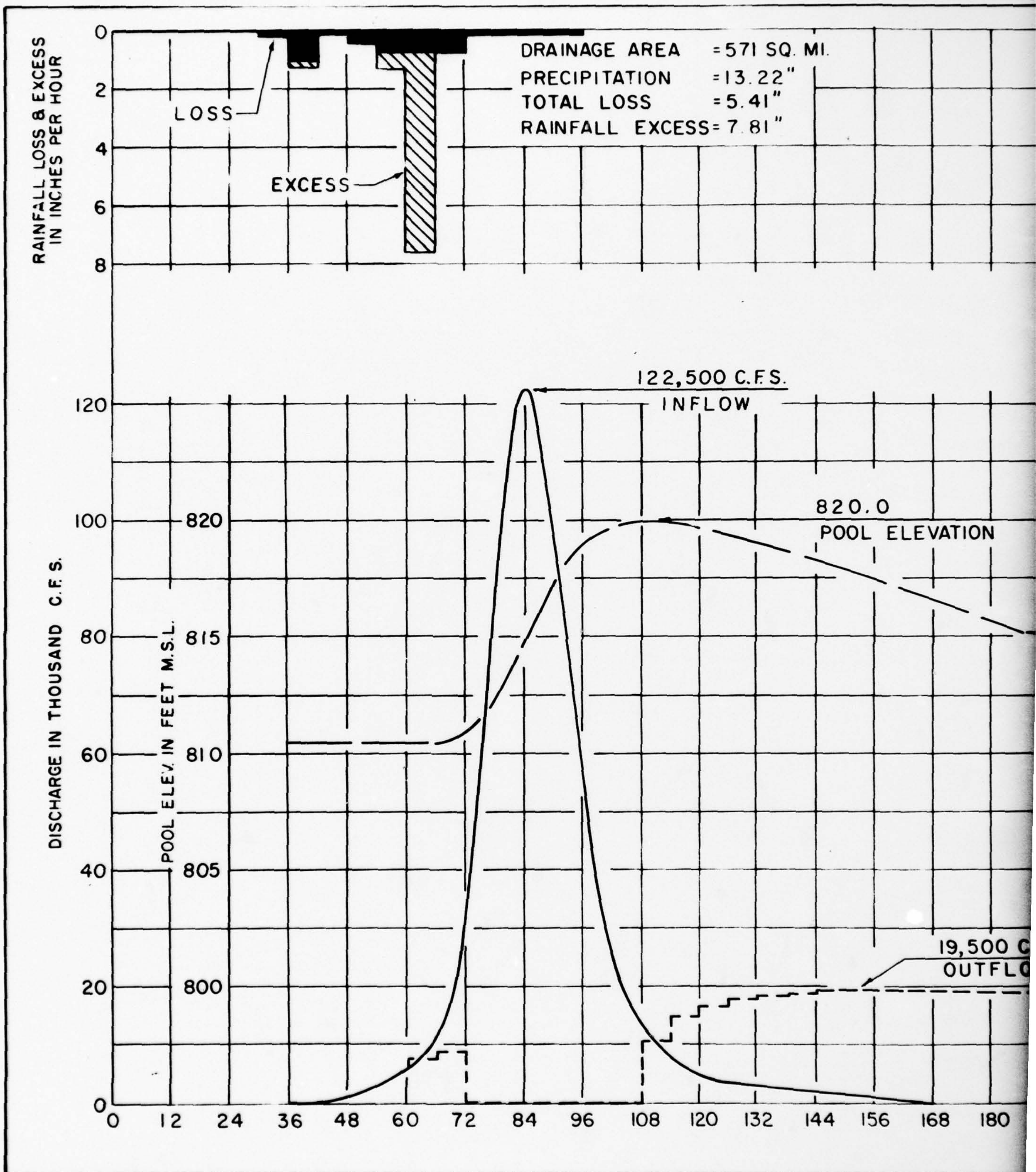

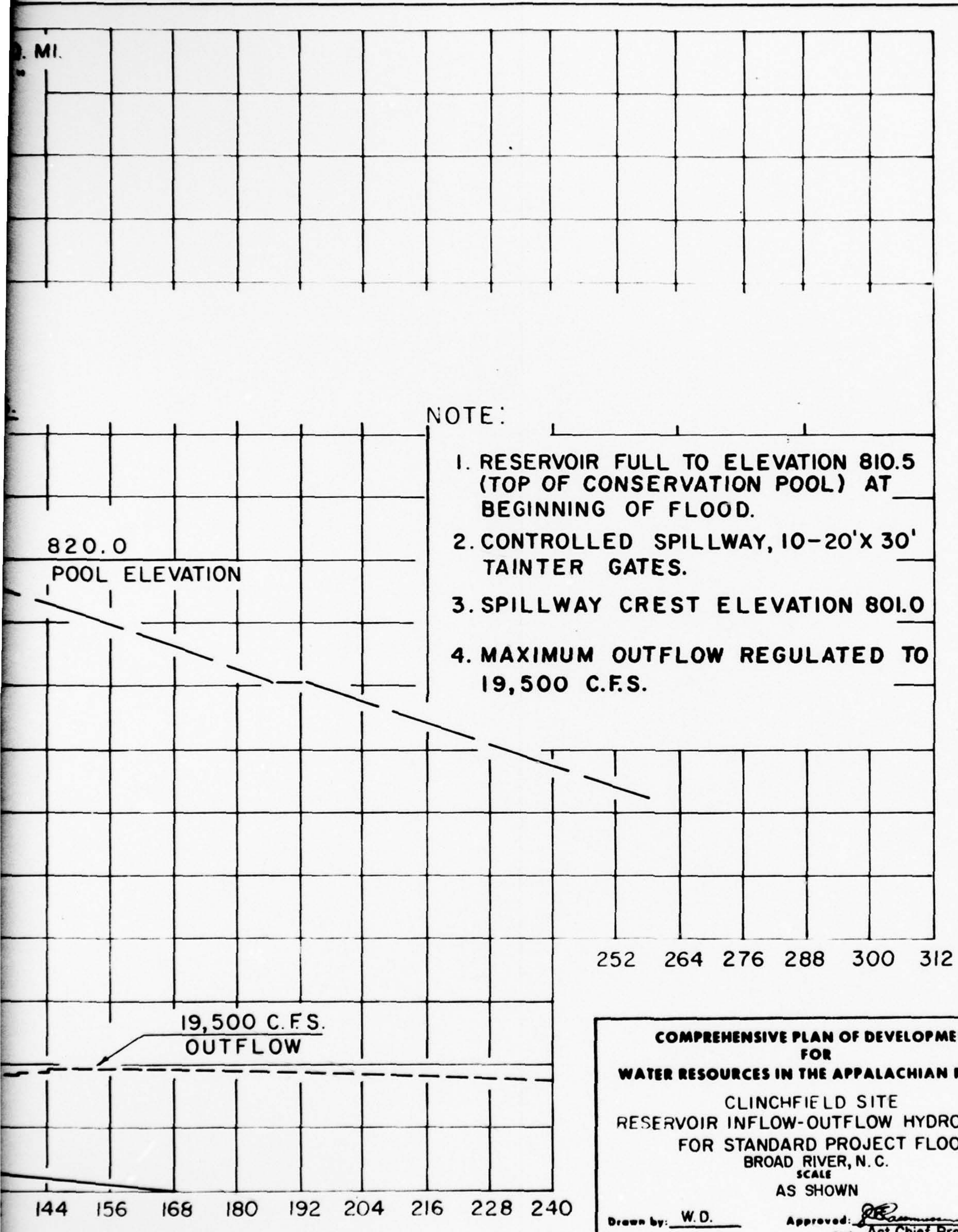

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD SITE
RESERVOIR INFLOW-OUTFLOW HYDROGRAPH
FOR STANDARD PROJECT FLOOD
BROAD RIVER, N. C.
SCALE
AS SHOWN

Drawn by: W.D.
Checked by: J.E.R.
Approved:
Title: Act. Chief, Proj. Plan. Br.
Date: JAN. 1968

EXHIBIT 5-8

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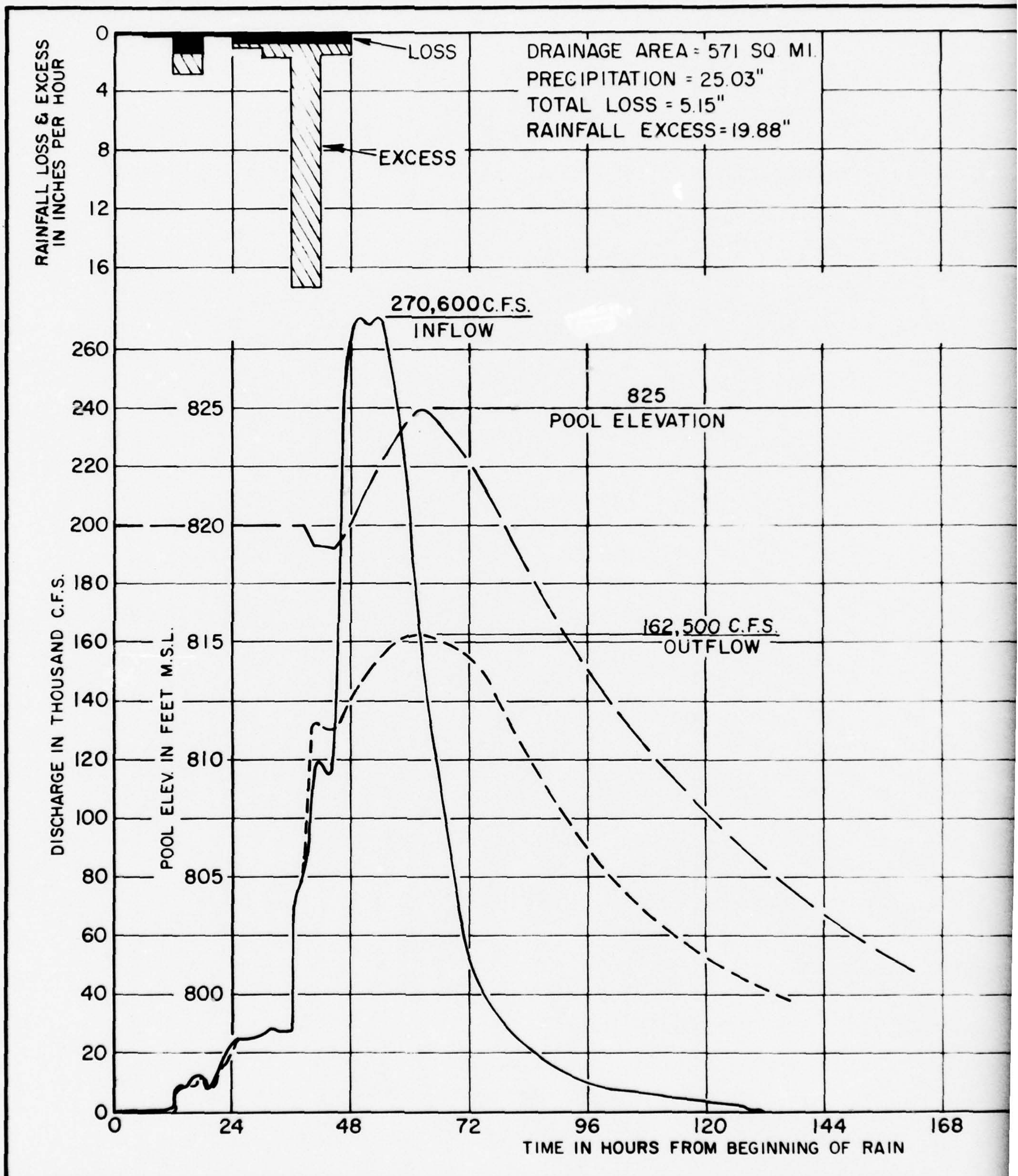

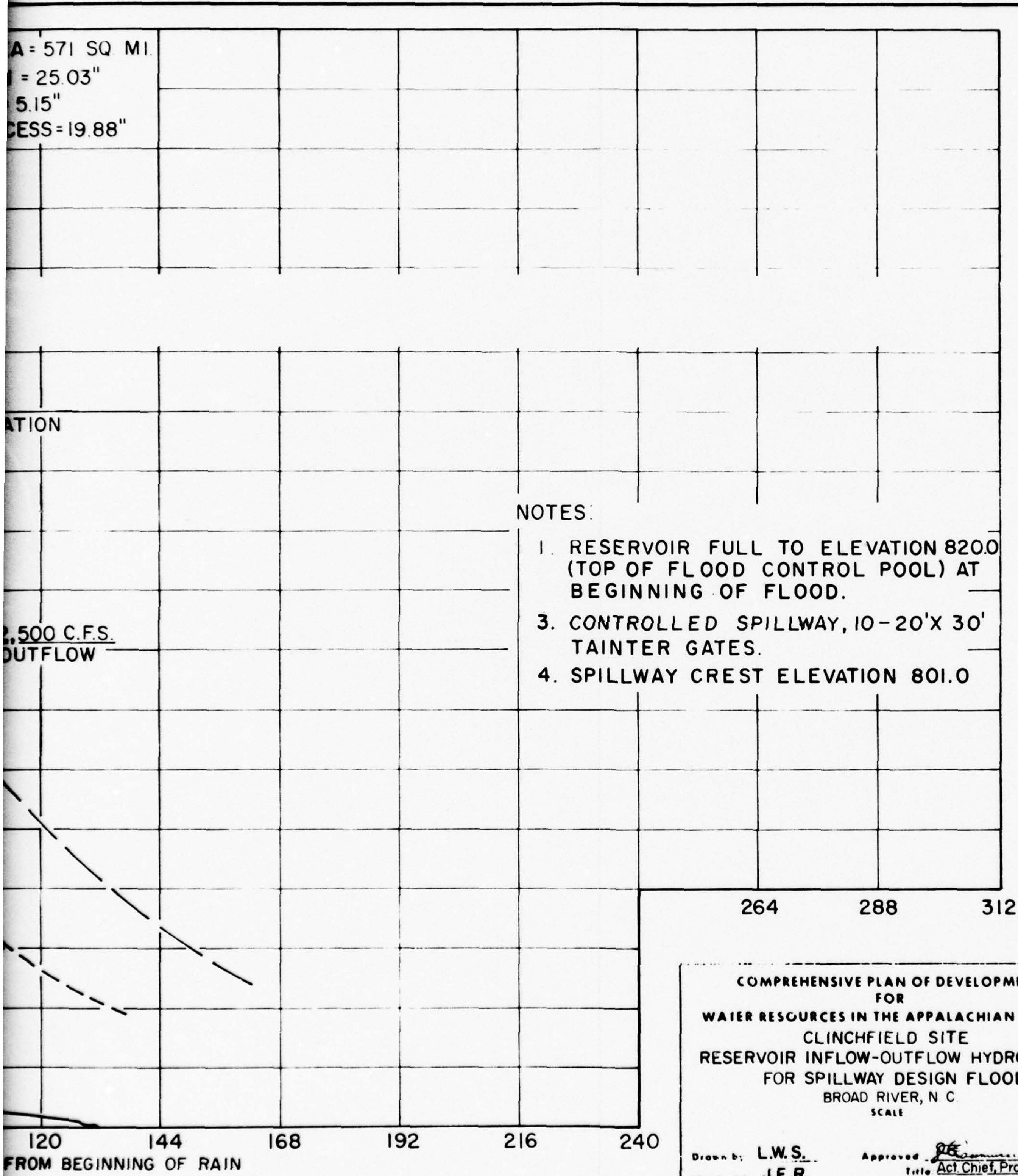

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLINCHFIELD SITE
RESERVOIR INFLOW-OUTFLOW HYDROGRAPH
FOR SPILLWAY DESIGN FLOOD
BROAD RIVER, N.C.
SCALE

Drawn by: L.W.S. Approved: [signature]
Checked by: J.E.R. Title: Act. Chief, Proj. Plan. Br.
Date: JAN. 1968

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Proposed Spillway

The proposed spillway would be a gated structure consisting of ten tainter gates each 30 feet wide by 20 feet high with top of gates at elevation 821 and crest of spillway at elevation 801. Future detail design studies may dictate somewhat different gate and spillway dimensions.

Tailwater

The project planning has not progressed sufficiently to present the final tailwater conditions. The preliminary tailwater curves for Clinchfield shown on exhibits 5-10 and 5-11 are based on one discharge measurement. The remaining points on the curves were computed using the slope-area method.

Outlet Works

Releases from the reservoir required for water supply and water quality would be relatively small compared to releases necessary for flood control. The recommended outlet capacity was based on downstream channel capacity, the required time involved to empty the flood control pool, in this case, between six and seven days, and to function partially as a service spillway in order to reduce the size of the emergency spillway. The outlet works to be provided in the Clinchfield Project which would satisfy the above functions are two reinforced concrete conduits having a diameter of 20 feet each. The intake tower would be designed to provide five multi-level intakes for one conduit only. The design discharge of the outlet works at maximum water surface elevation 825 is 32,500 cfs.

Flood Routing Conditions

It is expected the conduits proposed will be adequate for diversion during construction although no studies have been made in this regard. The project was designed to control all the floods of record, and the standard project flood, to non-damaging releases. The reservoir level was assumed to be at the top of the flood control space at the beginning of the spillway design flood and at the bottom of the flood control space at the beginning of the standard project flood. The conduit gates used to reduce reservoir surcharge storage during the routing of the Spillway Design Flood. While flood releases are expected to be large enough to permit rapid emptying of the reservoir, an assumption was made that the reservoir was filled at the beginning of the spillway design flood in order that the top of the dam be established at a conservatively high elevation.

In the course of further project planning, a gate regulation schedule would be developed to assure satisfactory spillway operation during exceptionally great floods. This schedule would provide the highest feasible degree of flood protection to the valley below the damsite and would restrict induced surcharge to tolerable limits.

After development of this schedule, a more detailed analysis of reservoir filling frequency would be made to determine whether the spillway design flood routing should be modified by starting with a partially filled flood control pool. The standard project flood would be routed through the reservoir, as the antecedent flood, with the reservoir at the top of the conservation pool and a seven-day interval between beginning of the respective storms, with a view to establishing the initial reservoir elevation for the spillway design flood.

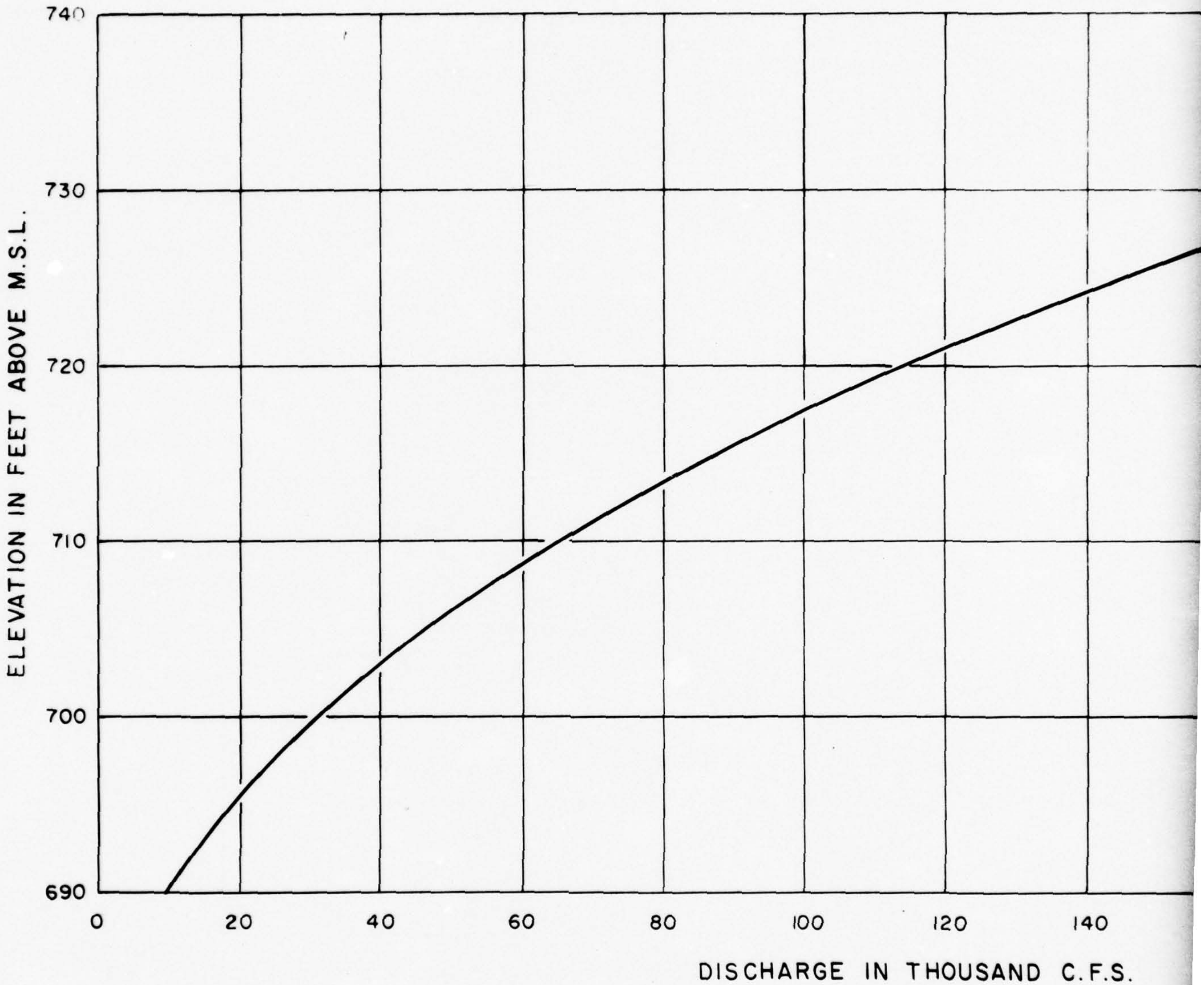
Spillway Design Flood

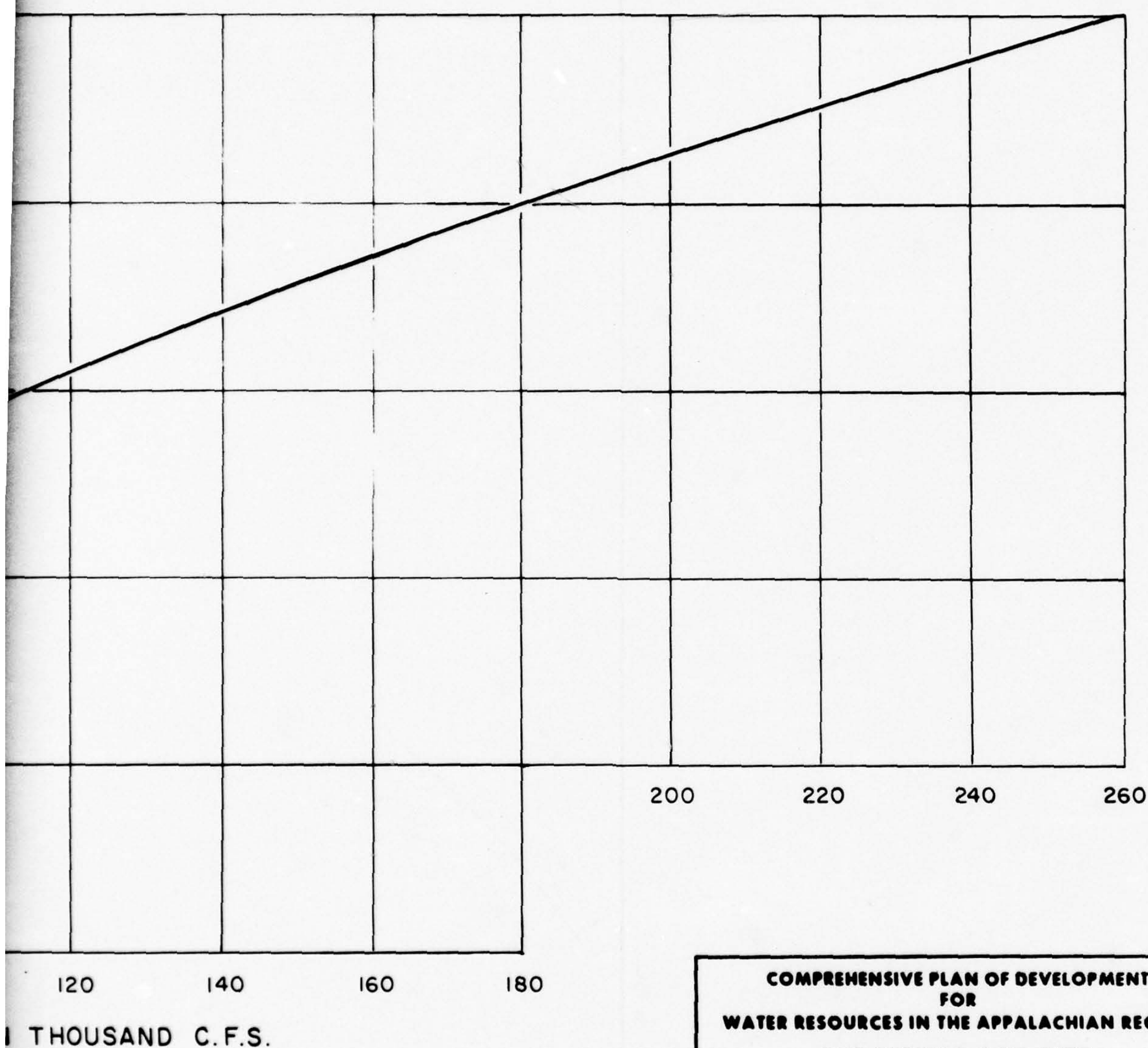
The spillway design flood was routed through the reservoir assuming the flood control space was filled at the beginning of the flood. Induced surcharge was not considered during this routing. This resulted in a maximum reservoir level of elevation 825.0 and maximum outflow of 162,500 cfs. Maximum depth above the spillway crest elevation of 801.0 was 24 feet. Reservoir inflow-outflow hydrographs for the spillway design flood are shown on exhibit 5-9.

Standard Project Flood

The standard project flood was routedthrough the reservoir assuming the reservoir level was at the bottom of the flood storage. This resulted in a maximum reservoir level of elevation 820.0 and a non-damaging outflow of 19,500 cfs. Reservoir inflow-outflow hydrographs for the standard project flood are shown on exhibit 5-8 . Reservoir storages required to control the standard project flood and the major floods of record are listed as follows:

Flood	Required Storage (ac.-ft.)	Required Storage (inches)
SPF	205,500	6.75
Aug 1928	172,100	5.65
Sep-Oct 1929	128,500	4.22
Apr 1936	101,500	3.33
Aug 1940	90,100	2.96


740
730
720
710
700
690
ELEVATION IN FEET ABOVE M.S.L.
0
20
40
60
80
100
120
140
DISCHARGE IN THOUSAND C.F.S.

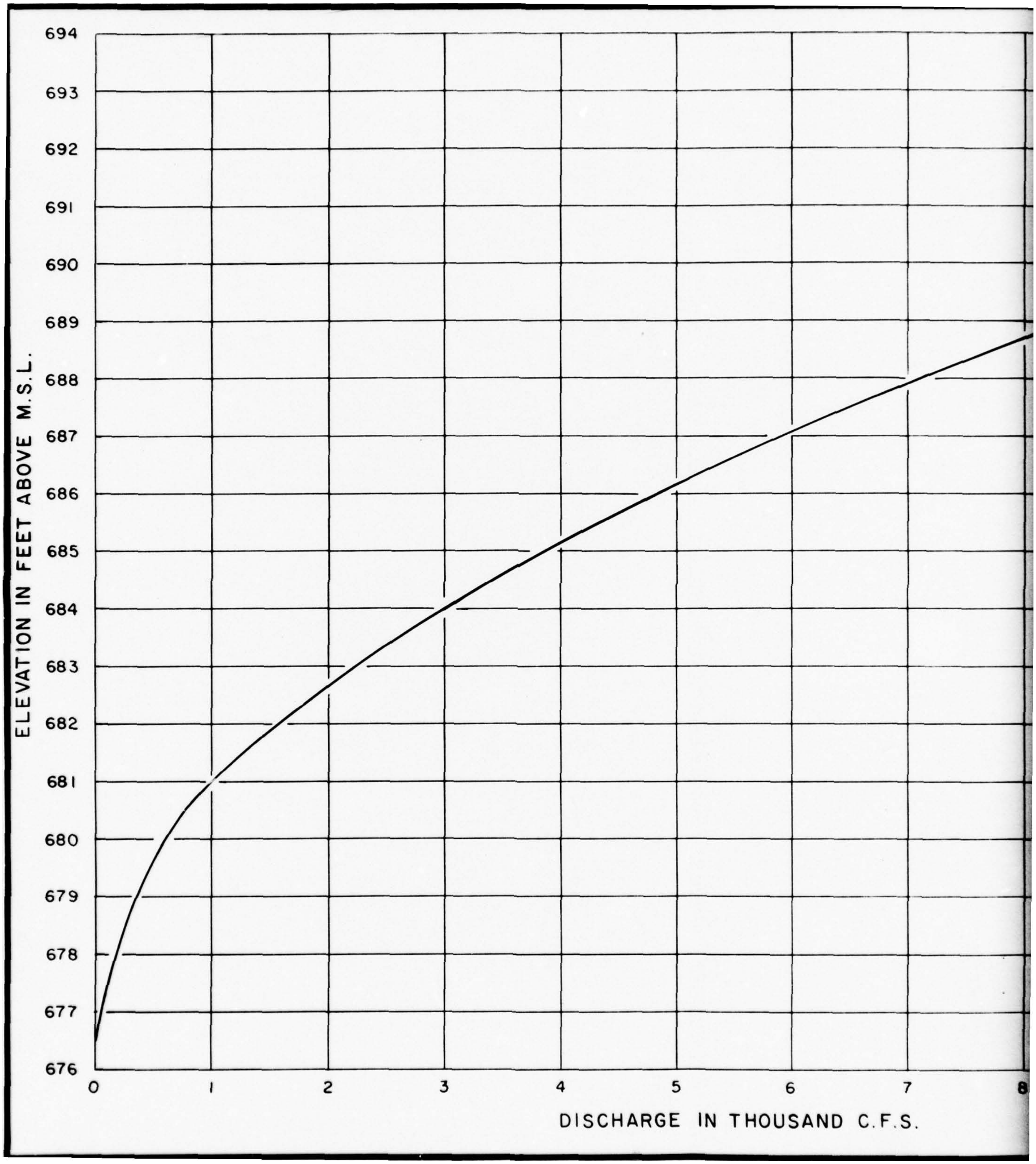


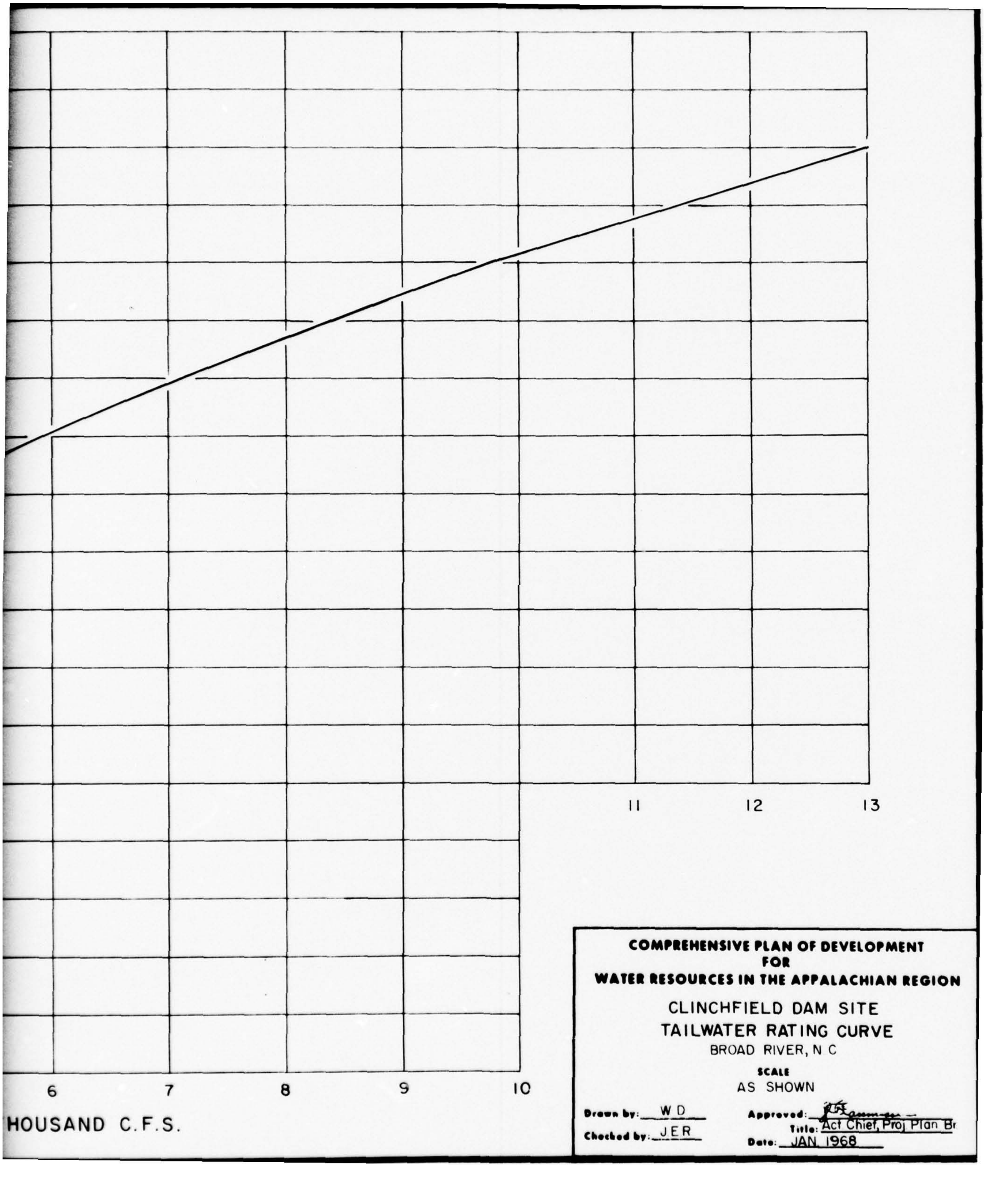
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD DAM SITE
TAILWATER RATING CURVE
BROAD RIVER, N. C.

SCALE
AS SHOWN

Drawn by: W.D. **Approved:**
Title: Act. Chief, Proj. Plan. Br.
Checked by: J.E.R. **Date:** JAN. 1968





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD DAM SITE
TAILWATER RATING CURVE
BROAD RIVER, N C

SCALE
AS SHOWN

Drawn by: W D
Checked by: J E R
Approved:
Title: Act Chief, Proj Plan Br
Date: JAN. 1968

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Clinchfield Reservoir as a Unit in System

At the present time, there are no other reservoirs contemplated for the Broad River Basin; therefore, the Clinchfield Project would be operated as a single unit.

Control Points

The primary control points for timing flood releases from Clinchfield are the river-gage stations used by the U. S. Weather Bureau for forecasting and reporting floods. These stations, all in South Carolina, are listed as follows:

Stream	Location of Gage	Flood Stage	Maximum Stage of Record Ft.	Maximum Stage of Record Date	Estimated Discharge at Flood Stage (cfs)
Broad River	Gaffney	10	19.8	14 Aug 1940	±19,000
Broad River	Blairs	14	40.0	17 Aug 1928	not determined
Congaree R.	Columbia	19	39.8	27 Aug 1908	±60,000

The channel capacity in the 25-mile reach between the damsite and the Gaffney station is approximately 19,000 cfs. Below Gaffney the Broad River safe channel capacity increases to a maximum of 60,000 cfs at Columbia. Travel time from the damsite to Columbia averages about two days. Optimum flood control benefits will be realized by utilizing forecasts of flows from the uncontrolled areas to determine allowable reservoir releases. Releases for water quality and water supply will be made in accordance with demands.

Release Limitations

Flood releases from Clinchfield will be withheld until there is no danger of adding to the flood peaks generated from the uncontrolled drainage area. Due to the large residual drainage area, it is anticipated that releases from Clinchfield Reservoir will occasionally be withheld several days in order to achieve maximum flood control benefits, since downstream control points often remain above flood stage several days.

Degree of Flood Control

Clinchfield Reservoir would protect the area downstream from the damsite from the standard project flood and all others of a lesser magnitude. This protected area is mostly rural but there are 11 small

communities which are subject to at least partial inundation by moderate floods and to more severe damages and disruption of community activities during major floods. The Clinchfield Reservoir would reduce flooding as far downstream as Columbia, S.C. Natural and regulated flows and stages for selected floods of record, Broad River near Gaffney index station (Reach 1), are given in Table 5-10.

Water Supply

The recommended plan for Clinchfield Reservoir provides an abundant source for water supply. Water releases from the reservoir or take-outs directly from the reservoir should not present any adverse effects on reservoir regulation.

Water Quality Control

Clinchfield Reservoir will provide the increased flows necessary to maintain water of objective quality at all points downstream with projected waste loads to year 2020.

Hydrologic Network

A hydrologic network will be established to permit (a) accumulation of pre-project streamflow and quality data, (b) current reporting of precipitation data, (c) records of reservoir inflow and outflow, (d) records of water quality parameters in the reservoir and of the inflow and outflow, and (e) current information on streamflow downstream.

Pertinent Data

Pertinent data for the Clinchfield Dam and Reservoir Project are given in Table 5-11.

11. GEOLOGIC

At the Clinchfield damsite, the Broad River has incised a valley to a depth of 160 to 200 feet below the adjacent uplands. The flood plain is about 600 feet wide and the 820 contours, top of flood control pool, are about 2,100 feet apart.

The topographic conditions of the abutment spur ridge are such that a saddle spillway for an earth dam could be provided back of either abutment; though the proximity to the discharge channel of the toe of the dam, and also of the Clinchfield Railroad bridge, might present some problems of protection against erosion.

TABLE 5-10

NATURAL AND MODIFIED DISCHARGES AND STAGES
BROAD RIVER NEAR GAFFNEY, S. C.
SELECTED FLOODS

Storm	Discharge-cfs Nat.	Discharge-cfs Reg.	Stage-feet Nat.	Stage-feet Reg.	Reduction
14 Aug 1940	119,000	95,000	19.78	17.95	1.83
6 Oct 1964	67,100	53,300	15.61	14.15	1.46
18 Sep 1945	61,600	48,900	15.35	13.63	1.72
4 Mar 1952	44,200	35,100	13.52	11.90	1.62
7 Jan 1946	43,400	34,400	13.38	11.82	1.56
13 Mar 1963	41,800	33,100	13.03	11.63	1.40

TABLE 5-11
CLINCHFIELD DAM AND RESERVOIR
PERTINENT DATA
DRAINAGE AREA 571 SQ. MI. (1.00" re= 30,453 A.F.)

Feature	Elev. (ft.msl.)	Surface Area (acres)	Total Capacity (ac.ft.)	Allocated Capacity (ac.ft.)	Runoff (in.)
Top of Dam	830.0				
Max. Water Surface	825.0				
					34.02
Top of F.C. Pool	820.0	23,180	1,036,000		
				205,500	6.75
Top of Conservation	810.5	20,220	830,500		
Water Supply				716,000	23.51
Water Quality				90,000	2.96
Sediment Pool	721.0	1,835	24,500		0.80
Streambed	677.0	--	--		

SPILLWAY
Crest Elev. 801.0 (Capacity = 652,170 ac. ft., 21.42")
Location - Left Abutment
Type - Controlled, 10 - 30' x 20' Tainter Gates
Peak Inflow SDF = 270,600 cfs
Peak Outflow SDF = 162,500 cfs (130,000 through spillway)

OUTLET WORKS
Conduit:
Double, reinforced concrete (five multi-level intakes, one conduit only)
Diameter (feet) 20.0
Length - 750 (feet)
Invert elevation at entrance (feet msl) 680.0
Design discharge at maximum water surface 32,500 cfs

SPILLWAY DESIGN FLOOD
Duration of storm (hours) 48
Total storm rainfall (inches) 25.03
Total storm runoff (inches) 20.06
Total volume of runoff (acre feet) 611,000

STANDARD PROJECT FLOOD
Duration of storm (hours) 96
Total storm rainfall (inches) 13.22
Total storm rainfall (inches) 7.81
Total volume of runoff (acre-feet) 237,800
Peak inflow to reservoir (cfs) 122,500
Peak outflow (cfs) 19,500
Required storage (acre-feet) 205,500
Required storage (inches) 6.75

At the time of the geologic investigation of the site, two axis lines, having a common left abutment ridge, were being considered. As relative disadvantages of the lower line include the fact that its right abutment would be 1,400 feet nearer the railroad bridge, and that this selection would prohibit the location of a saddle spillway on the left bank side and would involve greater construction costs, it was recommended that this line be abandoned.

Subsurface Investigations

At the time of the examination, 12 core borings had been completed along the two axis lines. Three borings ranging from 70 to 100 feet in depth were drilled in the left abutment. Three borings were made in the valley bottom, two of them on the lower axis and one on the upper. The right abutment of the upper axis was explored, four holes ranging up to 113 feet in depth and two holes ranging up to 110 feet in depth were drilled on the right abutment of the lower axis. Locations of the ten borings along the recommended axis are shown on exhibit 5-12.

To investigate the spillway possibilities for an earth dam, two additional holes were recommended, one each in the right and the left abutment ridges of the upper site. These have been completed and the data studied.

In addition to the above explorations, a bedrock profile was established along both axes by the seismic method. The geologic cross section and profiles are depicted on exhibit 5-12.

Geologic Setting

The Clinchfield dam and reservoir site is located in an area in which the dominant rock is the Carolina gneiss, though intrusive bodies of granite and other igneous rocks are not uncommon.

The Carolina gneiss, in the damsite area, consists of alternating beds of mica gneiss, granite gneiss, and mica schist. The dominant rock encountered in the borings, however, is a hard, well-banded mica gneiss made up of layers alternating in light and dark gray, consisting largely of feldspar, quartz, and mica, the dark layers having a preponderance of the black mica, biotite, over the light layers. Thin injections of granite gneiss occur throughout the formation, and at least one intrusive body of unmetamorphosed - and therefore much younger - biotite granite cuts the site area. This situation was encountered in boring no. 2 in the right abutment of the lower axis.

No faulting is known to occur in the site area. However, if faulting were present, it is unlikely that it would have been discovered because of the scarcity of outcrops.

Foundation Conditions

All the rocks known to occur in the damsite area are competent foundation materials and are sound and unweathered; they are capable of supporting a high concrete dam. However, they are deeply decayed in both abutment ridges. The deepest weathering occurs in the right abutment, where drill holes found no sound rock at depths ranging up to 113 feet. A considerably higher sound rock profile was found in the left abutment, but even here there are 60 feet or more of decayed rock, and nowhere along this ridge does the sound rock line rise above elevation 773 msl (28 feet below the spillway crest and 47 feet below pool elevation). The widely scattered borings of the valley bottom indicate that the sound rock line lies from 25 to 30 feet below the flood plain.

Because of the deeply weathered condition of the abutments and the presence of topographic and bedrock conditions that would permit the construction of a saddle spillway, an earthen dam would appear to be the most practicable and economical structure to consider for the site.

The overburden foundation for such a dam consists of alluvial sand and sandy silt on the flood plains and residual sandy, clayey silts on the abutments. As virtually all of the soils available for construction are of impervious types, it is apparent that stability requirements of the embankment, rather than of the foundations, will control the design slopes.

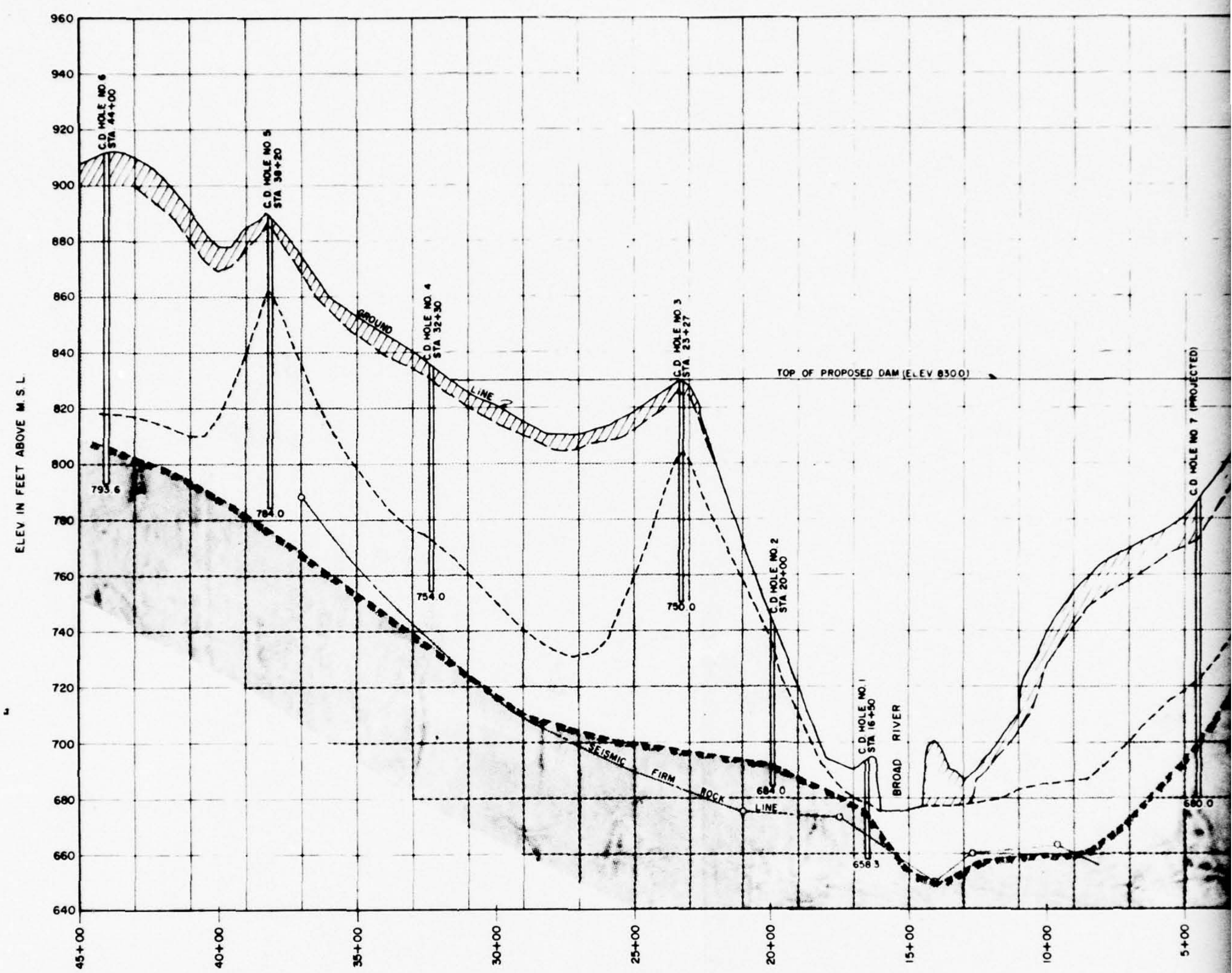
Conditions Bearing on Spillway Location

The problem of locating the spillway involves consideration of the proximity of the toe of the dam, as well as of the railroad bridge, to the discharge channel. If the spillway were located in the right abutment ridge, its discharge would enter the river virtually at the toe of the dam, assuming an embankment slope of 1 on 4. Therefore, this site is believed to be out of the question. The location at the left abutment saddle would discharge approximately 600 feet below the toe of the dam, and approximately 1,000 feet above the railroad bridge. While the use of this site may involve some problems of protection against erosion, it appears to be the most favorable one available.

Foundation rock for the spillway structure is indicated at a general elevation of from 765 msl to 773 msl in the vicinity of borings 9 and 10, or at a depth of 47 to 55 feet below pool elevation.

Conditions Bearing on Tunnels

The topographic and bedrock conditions of the abutment ridges are such that any tunnels driven for diversion, flow regulation, or penstocks would be long and costly. It is suggested that consideration be given to the construction of cut-and-cover conduits located on rock adjacent to one of the abutments.

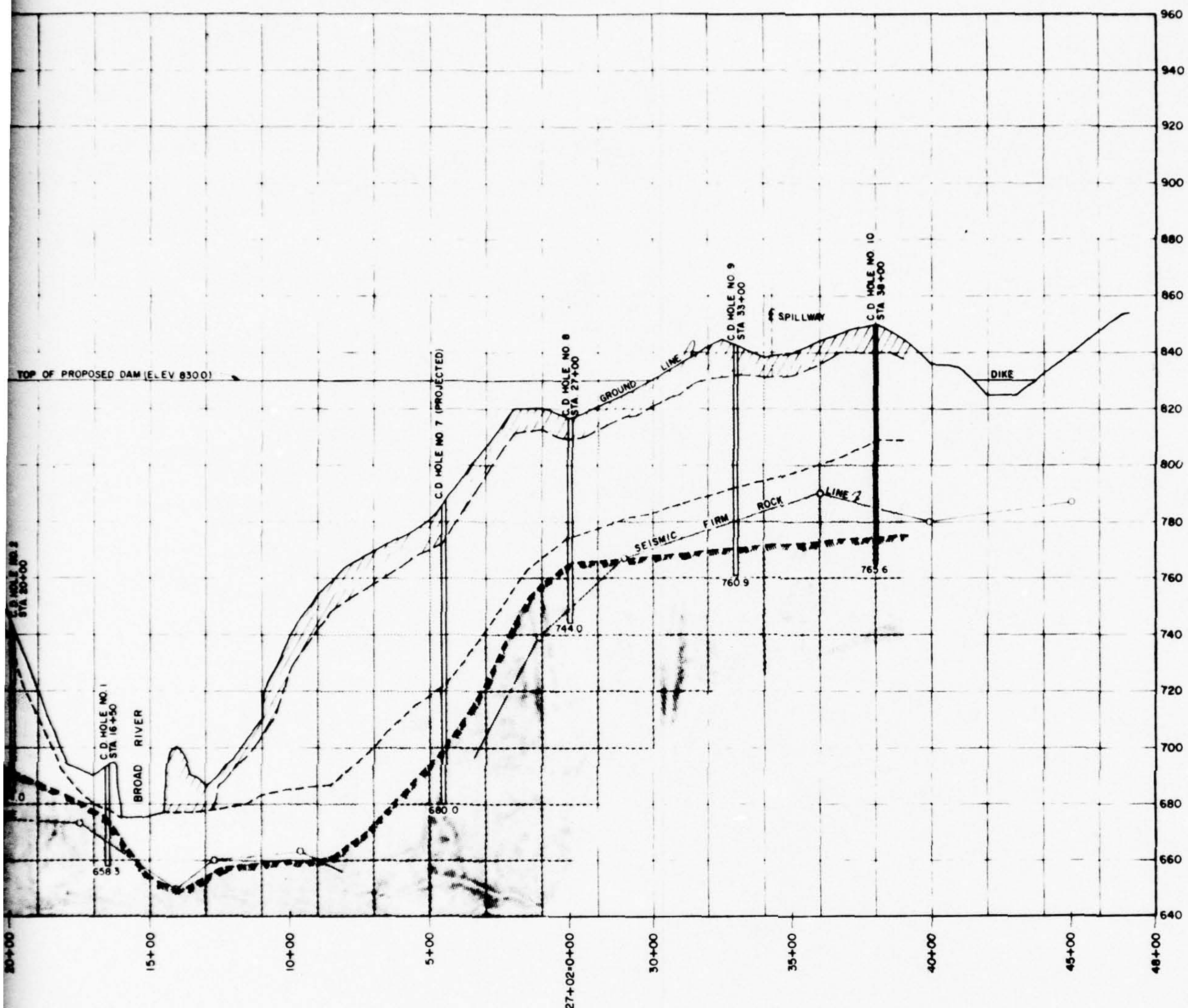


CROSS SECTION CLINCHFIELD DAM SITE

(LOOKING UPSTREAM)

SCALE: HORIZ 1" = 200'
VERT 1" = 20'

2



ECTION CLINCHFIELD DAM SITE

(LOOKING UPSTREAM)

SCALE: HORIZ 1" = 200'
VERT 1" = 20'

LEGEND

SOIL (RESIDUAL SILT, CLAY, LITTLE SAND OR ALLUVIAL SAND)

DECOMPOSED ROCK (MICACEOUS SILT, LITTLE CLAY AND SAND)

WEATHERED ROCK (CHLORITE SCHIST)

SOUND ROCK (CHLORITE SCHIST)

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD DAM SITE
SITE CROSS SECTION & GEOLOGY

BROAD RIVER, NORTH CAROLINA
SCALE
AS SHOWN

Drawn by LWS
Checked by JER
Approved:
Title:
Date: JANUARY 1968

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Leakage Conditions

The nature of both the rocks and the soils throughout the reservoir area is such that a tight reservoir seems assured if the proper precautions are taken to prevent serious leakage through the dam foundations. A cut-off trench back-filled with impervious materials, both in the valley bottom and in the abutments, will probably be necessary to prevent dangerous seepage through the soil foundations. It is believed that the valley bottom cut-off should go to rock and provision be made for a shallow grout curtain below the trench. Because of the heavy cover of overburden on both abutments, it is unlikely that grouting will be necessary in the abutment ridges. However, permeability and stability against saturation and drawdown in these abutment ridges should be investigated in the course of advanced project planning and design.

Materials of Construction

The soil materials of the area are of three general types: (1) Residual sandy, clayey silts; (2) decomposed gneiss; and (3) alluvial sands and sandy silts. The residual soils are generally only a few feet thick. Below these occur thick zones of decomposed gneiss and schist. In general, this material is a micaceous silt with varying amounts of sand and a little clay. Both of these types when compacted should make a satisfactory impervious fill. The alluvial sands and sandy silts are confined to the flood plains and are therefore restricted in occurrence. As the flood plains are narrow, and much of the fill lies below water table, the quantities of pervious or semi-pervious materials appear to be quite limited. The impervious materials occur in great abundance, however, and favorable borrow areas may be found throughout the uplands.

Rock is generally too deeply buried beneath the soil mantle to provide favorable quarry sites, but it is probable that suitable stone for embankment protection and drains can be found within economic range of the site. The local rock, because of its foliated structure, would be unsatisfactory for aggregate purposes, and it is probable that all aggregate would have to be hauled in by rail from outside sources, probably from Gaffney, South Carolina, where commercial deposits of marble occur.

Archaeological and Historical Sites

Numerous sites of archaeological and historical interest are lcoated in the area which would be inundated by the reservoir. During the interim between authorization and construction of the project, personnel of the Corps of Engineers and the National Park Service would survey these sites and salvage appropriate objects for cataloguing and preservation.

Conclusions

No geologic conditions have been discovered at the Clinchfield damsite that would preclude the construction of a safe and effective multi-purpose dam of either concrete or earthen type. Deep weathering of the abutment ridges, and the presence of topographic conditions moderately favorable for the construction of a saddle spillway, favor earth dam construction. Materials for the construction of an earthen dam are available in the site locality.

12. STRUCTURAL

Dam and Dikes

The choice of structural design considerations in the case of Clinchfield Dam was in reality dictated by the needs of the area. For, structurally, it would have been possible to have formulated almost any type and size of dam to fit either single, or multi-purpose. Maximum utilization of the site afforded by nature fits the criterion of fulfilling the needs of the area at the least expenditure of funds by fully developing the site. The Clinchfield project was designed to provide storage space for flood control, water supply, water quality control, sediment deposition, and to support recreational activities associated with the project. Exhibit 5-1 shows the Clinchfield Reservoir and delineates the top of flood control and conservation pools. Exhibit 5-3 shows the damsite plan and pertinent details including a typical section through the dam. Exhibit 5-7 shows area and capacity curves of the project.

Spillway

Since the initial major beneficial use of the project is to be derived from flood control and water quality control, spillway design considerations included the maximization of net flood control benefits. Optimum design considerations resulted in selection of a controlled spillway with crest elevation 801.0. Discharges would be controlled by ten 30 foot by 20 foot tainter gates. A spillway plan and section are shown on exhibit 5-3. The pertinent data concerning the spillway have been tabulated in table 5-11.

Outlet Works

The outlet works would consist of two 20-foot diameter conduits with an intake structure which would provide multi-level intakes for one conduit. Selection of the most feasible intake invert elevations would be coordinated with the Fish and Wildlife Service and FWPCA to allow selective withdrawals whenever stratification creates the need. In this manner the downstream areas would be assured of the best quality of augmentation flows possible, dependent on quality of inflows and effect of storage on quality parameters. Utilization of these conduits for ordinary operational releases would tend to minimize stagnation of the lowermost conservation pool.

13. RELOCATIONS

The proposed Clinchfield project is traversed by one U. S. Highway (221), one State Highway (N.C. Highway 108), and numerous paved and unpaved county roads. The Clinchfield Railroad crosses Broad River below the proposed damsite, and the line lies along the edge of the reservoir for about 1-1/4 miles near Harris, North Carolina. There are two high voltage power transmission lines and one natural gas pipeline located within the limits of the reservoir area. The town of Rutherfordton uses stabilization ponds for treatment of its sewage wastes and these ponds will be subject to inundation by the impounded reservoir waters.

Highways

Both U. S. Highway 221 and State Highway 108 will be relocated in order to maintain the existing transportation network. The relocation of these highways requires three new bridges. The county roads which can be economically relocated or raised have been included in the relocation plan.

Railroads

Since the route of the Clinchfield Railroad lies below pool elevation 820 feet msl as it traverses the eastern edge of the reservoir just before it reaches Harris, North Carolina, diking will be necessary to protect the embankment, ballast ties, and tracks from damaging water levels. There are about 7,000 linear feet of dike averaging 30 feet in height required for this purpose.

Utilities

The natural gas pipeline traversing the reservoir area will be relocated or armored with a concrete protective encasement for approximately 15,000 feet of length. The high voltage power lines are presently carried by steel towers. It is estimated that five triple-type steel towers and seven single-type steel towers will provide adequate clearance for these utilities.

Sewage Treatment Plant

It is proposed to replace the existing sewage stabilization ponds at Rutherfordton with a new secondary-type treatment plant.

Cemetaries

There are four churches located in the reservoir area and an estimated 400 graves are associated with these. In addition, it is estimated that there are about 900 graves located in family plots, for a total of about 1,300 graves requiring removal.

14. REAL ESTATE

Lands Required

Policies defined in ER 405-2-150 - "Planning and Project Authorization - Civil Works Projects," dated 11 February 1966 were used as the basis for land acquisition to determine the necessary lands to be acquired for the proposed Clinchfield Reservoir project. Considerations of lands required for the proposed Clinchfield Reservoir project are as follows:

a. Acquisition of lands for reservoir project
b. Lands for reservoir construction and operation
c. Additional lands for correlative purposes
d. Easements
e. Mineral rights
f. Buildings

Multiple-Purpose Project

The proposed Clinchfield Reservoir project is a multiple-purpose reservoir. Therefore, determination of lands to be acquired was based on criteria set forth in the regulation cited above.

Reservoirs

The necessary lands to be acquired in fee title for the Clinchfield project are stated below. Since the reservoir area of the project has rather precipitous side slopes, a reasonable freeboard allowance will not meet the criterion of a minimum of 300 feet horizontally from the full pool, elevation 820. Consequently, land purchase estimates are based on acquiring a 300-foot strip of land contiguous to the full pool shoreline. The acreage to be inundated by the full pool at the Clinchfield site is 23,180 acres. There are 12,820 acres in the 300-foot horizontal strip surrounding the pool. This totals 36,000 acres to be acquired for the Clinchfield Reservoir.

Dam and Appurtenances

The lands needed for construction of the dam and its appurtenant works have been included in the above acreage estimate.

Recreation

In addition to the lands to be acquired for other project purposes as stated above, 4,000 acres are to be acquired for the recreational development of the Clinchfield site. These lands would be acquired in fee simple.

Other Specific Needs

The Bureau of Sports Fisheries and Wildlife have specified a need for 4,000 acres of land located outside the project area for wildlife mitigation. The Bureau of Mines, Department of the Interior, reported no mineral values or workings within the proposed reservoir area except for a granite-crushing operation which would be inundated by the Clinchfield project. This operation, including a quarry, involves about 43 acres. There will be no need to acquire easements for the proposed Clinchfield Project.

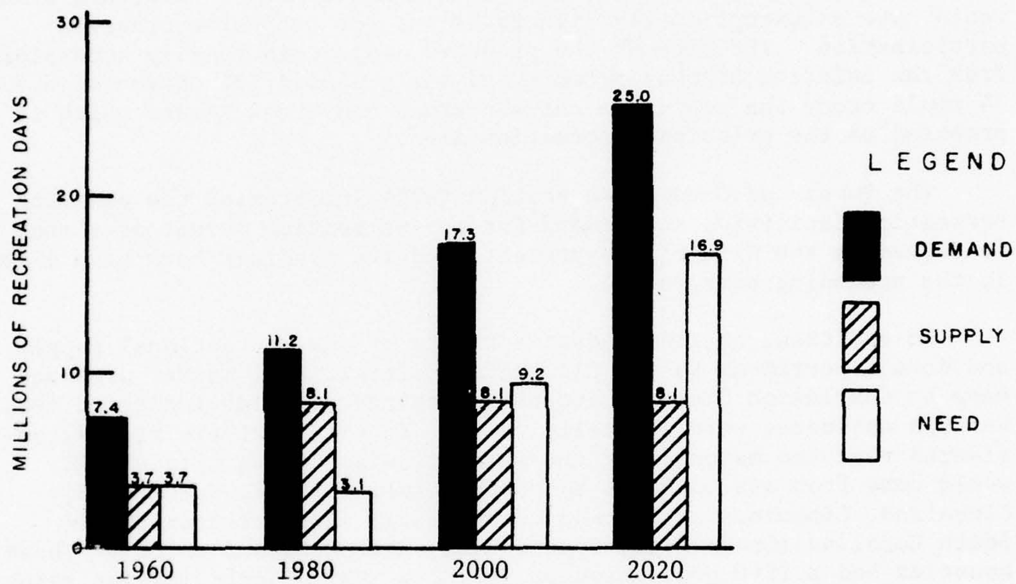
15. RECREATION - THE CONCEPT EVOLUTION

The proposed Clinchfield Reservoir, with an area of 20,220 acres and a 386-mile shoreline, indented with many coves and tributary arms, would have an exceptionally high potential for outdoor recreation participation. The site of the proposed project is readily accessible from the existing highway network and the proposed relocation of U.S. 74 would cross the peninsula between Broad and Green Rivers which is proposed as the principal recreation area.

The Bureau of Outdoor Recreation (BOR) inventoried the existing recreation facilities and demand for the recreation market area that can be served by the Clinchfield project, and its findings have been cited in the preceding paragraph 5.

In addition, an independent estimate of the recreational supply and demand pertinent to the Clinchfield recreational market area was made by Charleston District, Corps of Engineers, which indicated that the BOR estimates were generally valid. In this analysis it was considered that the majority of the recreationists using Clinchfield would come from six counties in North Carolina (Polk, Rutherford, Cleveland, Lincoln, Gaston, and Mecklenburg) and four counties in South Carolina (Greenville, Spartanburg, Cherokee, and Union). These counties had a 1960 population of 997,014. Using participation rates for the southeast given in ORRRC Report No. 19, it was estimated this area would have a demand for 11.10 activity-days per capita annually for the water-based activities of boating, swimming, picnicking, and camping. For the total market area, using benchmark population projections, the 2020 recreational demand was estimated to be about 37,596,000 activity-days per year, versus about 31,600,000 activity-days appropriate for the market area as delineated by BOR. The 13 existing public and private and 3 planned reservoirs (Lake Jocassee, Lake Keowee, and Trotters Shoals) considered to be effective competitors for the Clinchfield recreational market were assumed to have an ultimate recreational capacity of 112 activity-days/year/acre

of water surface. The effective capacity of each competitor was reduced in proportion to its distance from Clinchfield to determine the Clinchfield market area demand that it could effectively meet. These estimates indicate that these 16 reservoirs could supply (in 2020) about 12,200,000 of the annual activity-days exerted by the Clinchfield recreational market, leaving about 25,400,000 activity-days to be partially met by Clinchfield in 2020. A summary of this analysis (in recreation-days) follows.



THE CLINCHFIELD RECREATION MARKET

Demand, Supply, and Needs, which can be partially met by Clinchfield Reservoir.

The Bureau of Outdoor Recreation stated that there is an existing and future need for additional recreation development. The minimum development considered for the Clinchfield site would accommodate 300,000

recreationists annually. The recommended maximum recreation development would support annual attendance of 570,000 to coincide with initial filling of the reservoir, and 5.7 million with the ultimate development. After the initial facilities required for the maximum development plan have been installed, additional installations would be made to accommodate the increased attendance as needed. It is expected that all areas would be completely developed by the year 2000. Purchase of 4,000 acres specifically for recreation, in addition to land required for the reservoir project itself, was recommended by the BOR. The major portion of this acreage would be located on the peninsula between the Broad and Green River arms of the reservoir.

The proposed reservoir and its recreation areas are not near any national forest area, and it is therefore appropriate for the recreational areas to be administered by non-Federal agencies. The proposed development is compatible with the comprehensive statewide outdoor recreation plans of North Carolina.

The proposed recreational development is shown in Exhibit 5-13 and the costs are given in Tables 5-12 and 5-13. Costs are a function of the peak usage and activities provided for in the project. Design of facilities is based on the "day load," which, for the initial usage is 7,500, and for the future increment is 88,800. These, when adjusted for turnover, result in "design loads" of 3,800 and 44,400, respectively, which are then used in estimating the number of unit facilities required. The design load was used to estimate the costs of facilities required to permit the following activities: boating, fishing, picnicking, sightseeing, swimming (including water-skiing), and camping.

Additional information pertaining to the proposed recreational development of the Clinchfield Reservoir project may be found in Appendix F, Recreation and Aesthetics.

Fish and Wildlife

Recreational use and values associated with fishing and hunting were evaluated by the Bureau of Sport Fisheries and Wildlife of the U. S. Department of the Interior. The expected fishermen visitation reported by this agency entered into the design and cost estimates of some of the recreational facilities mentioned above, since these fishermen also use camping areas, parking sites, launching ramps, etc. The Bureau reported that the Clinchfield Reservoir area, without the project, supported about 8,900 fisherman-days annually, with a benefit of $5,300; that with the project it would support about 226,400 man-days, with an equal dollar value of benefits; and that the net betterment would be 217,500 fisherman-days, and a benefit value of $221,100. With respect to wildlife resources (evaluated in terms of hunting values), the Bureau estimated that the project would eliminate about 5,700 man-days of hunting, but stated that this could be compensated for by acquiring 4,000

acres of land outside the project area, adjacent to the Green River Wildlife Management area, which is owned in fee by the North Carolina Wildlife Resources Commission. Present planning includes an evaluation of the costs of these wildlife damage mitigation measures which preserve, but result in no net increase to the hunting opportunities of the reservoir and its environs.

Additional data concerning fish and wildlife recreation are presented in Appendix G.

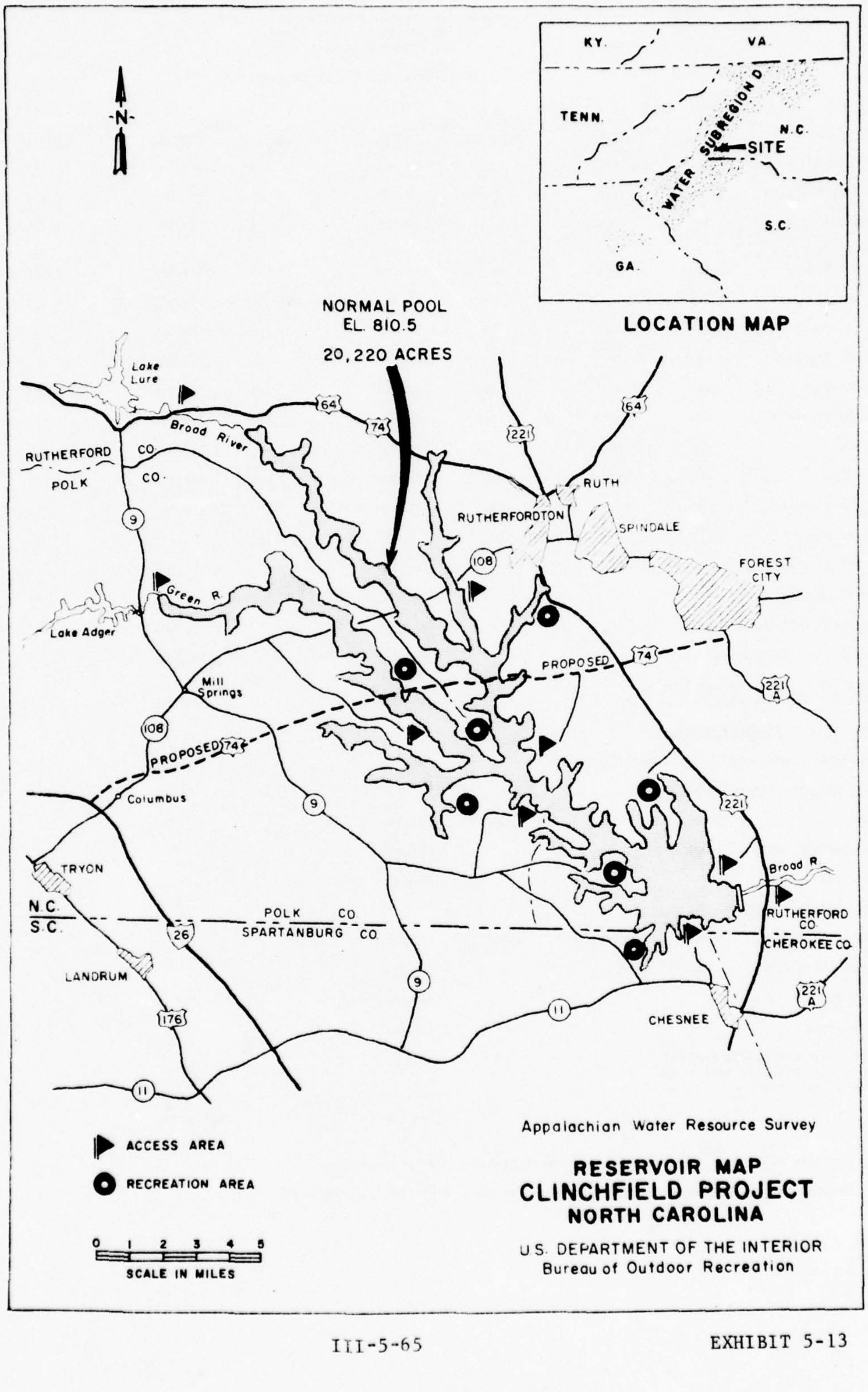

KY.
VA.
TENN.
N.C.
WATER SUBREGION D
SITE
S.C.
GA.
LOCATION MAP
-N-
NORMAL POOL
EL. 810.5
20,220 ACRES
Lake Lure
64
74
221
64
Broad River
RUTHERFORD CO.
POLK CO.
RUTH
RUTHERFORDTON
SPINDALE
FOREST CITY
9
108
Green R
Lake Adger
PROPOSED 74
221 A
Mill Springs
108
PROPOSED 74
Columbus
9
221
TRYON
Broad R
N.C.
S.C.
POLK CO
SPARTANBURG CO
26
RUTHERFORD CO.
CHEROKEE CO.
LANDRUM
9
11
221 A
176
CHESNEE
11
Appalachian Water Resource Survey
ACCESS AREA
RECREATION AREA
RESERVOIR MAP
CLINCHFIELD PROJECT
NORTH CAROLINA
0 1 2 3 4 5
SCALE IN MILES
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Outdoor Recreation

EXHIBIT 5-13

TABLE 5-12

Detailed Estimate of General Recreation
Fish and Wildlife Recreation and
Wildlife Mitigation Costs

CLINCHFIELD RESERVOIR, NORTH CAROLINA

Item	Unit	Unit Cost	Initial Quantity	Initial Amount	Future Quantity	Future Amount	Total Quantity	Total Amount
Picnic Units	Ea.	$ 2,600	38	$ 98,000	484	$1,258,400	522	$1,357,200
Picnic Shelters	Ea.	14,000	2	28,000	20	280,000	22	308,000
Camping Units	Ea.	1,800	120	216,000	1,954	3,517,200	2,074	3,733,200
Parking, Fishing, Swimming	Ea.	420	342	143,600	3,164	1,328,800	3,506	1,472,400
Swimming Beach	S.F.	1.50	30,400	45,600	488,400	732,600	518,800	778,200
Change Houses	Ea.	3,500	4	14,000	49	171,500	53	185,500
Launching Ramp	Lanes	43,200	7	302,400	78	3,369,600	85	3,672,000
Sanitation Units	Ea.	11,400	23	262,200	278	3,169,200	301	3,431,400
Water-Dayuse Wells	Ea.	1,500	51	76,500	592	888,000	643	964,500
Roads	Mi.	78,000	10	780,000	30	2,340,000	40	3,120,000
Trails	Mi.	9,500	10	95,000	115	1,092,000	125	1,187,000
Signs & Markers	L.S.		L.S.	1,400	L.S.	16,000	L.S.	17,400
Landscaping	L.S.		L.S.	8,000	L.S.	93,200	L.S.	101,200
Subtotal - FACILITIES				2,072,000		18,257,000		20,329,000
Contingencies				434,000		3,651,000		4,085,000
Engineering & Design				100,000		876,000		976,000
Supervision & Administration				183,000		1,595,000		1,778,000
Total Cost General Recreation & Fish and Wildlife Facilities				2,789,000		24,379,000		27,169,000
FACILITIES - Wildlife Mitigation								
(Parking, Roads, etc.) (incl. contingencies)				20,000				20,000
REAL ESTATE - General Recreation								
Land	Acres	234	4,000	935,000				935,000
Acquisition Costs	Job			25,000				25,000
Subtotal				960,000				960,000
REAL ESTATE - Wildlife Mitigation								
Land	Acres	117a, b	4,000	467,000				467,000
Acquisition Costs	Job			13,000				13,000
Subtotal				480,000				480,000
Total Land				1,440,000				1,440,000
Total Cost General Recreation and Fish & Wildlife Recreation Land & Facilities				4,249,000		24,379,000		28,618,000

a. Includes Land, Improvements, Severance, Resettlement, and Contingencies

b. Assumed to be undeveloped woodlands adjacent to Green River Wildlife Refuge

TABLE 5-13

Detailed Summary of Construction and Investment Costs, Annual Charges, Annual Benefits, and Visitors (in 1,000) General Recreation and Fish and Wildlife Recreation

CLINCHFIELD RESERVOIR, NORTH CAROLINA

	Initial Increment	Future Increment	Total	Future Increment Discounted	Total w/Future Increment Discounted
CONSTRUCTION COSTS:					
Facilities - Gen. Rec., F&WL	2,789	24,379	27,168		
Real Estate - Gen. Rec.	960	0	960		
Total Construction Costs	3,749	24,379	28,128		
INVESTMENT COSTS:					
General Recreation and F&WL Construction	2,789	24,379	27,168		
Interest during Const (3 yrs)	136		136		
Real Estate - Gen. Rec.	960		960		
Interest during Const (3 yrs)	47	____	47		
Total Investment - General and Fish and Wildlife Land and Facilities	3,932	24,379	28,311		
ANNUAL CHARGES: Specific-Use Lands & Facilities					
Interest on Investment 1/	128			325	453
Amortization of Investment 1/	5			14	19
Major Replacement 2/	23			76	99
Direct Operation & Maintenance	192			455	647
Loss in Land Productivity 3/	17			____	17
Total Annual Economic Charges	365			870	1235
Total Annual Financial Charges	348				1218
VISITATION: (1,000)					
General Recreation	570	5,130	5,700		
Fishing (Pool)	226*	0	226		
Hunting (No Net Gain)	0	____	____		
Total Visitation	796	5,130	5,926		
BENEFITS:					
General Recreation	713	6,412	7,125		3172
Fishing (Pool)	221**	0	221		221
Hunting	0	0	0		____
Total Benefits	934	6,412	7,346		3393

* Net increase is 217,500 man-days.
** Based on net increase

1/ Interest project life 100 years 3.25%, Amortization .00138, and discount factor .4104.
2/ Major Replacement - Initial Facility Investment x 1/3 x .0252.
Future Increment Facility Investment x 1/3 x .0097.
3/ Loss in Land Production (0.0500 - 0.0325) x value of land.

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SECTION IV - COST ESTIMATES

16. PROJECT COSTS AND ASSOCIATED PROJECT COSTS

The total cost of construction of the Clinchfield Reservoir project is estimated to be $58,565,000. Estimates of first costs for the dam and reservoir include cost of initial construction, future recreation facilities, contingencies, engineering, design, supervision, and administration. Construction costs were based on the detailed layouts shown in exhibit 5-3 and design considerations discussed in Section III. Unit prices for the cost estimate are based on prices for similar work in nearby areas and are adjusted to December 1967 price levels. Allowances for contingencies reflect the level of uncertainty accompanying cost estimates developed in survey investigation depth. Detailed cost estimates are shown in tables 5-14 through 5-18.

Total investment costs and annual financial charges were developed for the Clinchfield Reservoir and associated developmental plan. Investment costs include construction costs plus interest accrued during the construction period (3¼ percent interest in three-year construction period). Annual charges were computed at the 3¼ percent interest rate and 100-year amortization period. Operation and maintenance costs were based on current costs for similar projects. An allowance for major replacement is included to permit the replacement of the operating equipment.

Associated project costs include those additional non-project costs necessary to realize the project benefits. In the case of water supply, it includes costs of constructing and operating the necessary water conveyance system. While a detailed study of such a conveyance system is recommended, to include the feasibility of serving the town of Greenville, an estimate has been made (table 5-19) only for a system serving Spartanburg, a point of definitely known demand. The assumptions made in the estimate given in table 5-19 were that Spartanburg's 100 mgd demand would be met in two construction stages, 25 years apart. The first increment would be sized to provide 50 mgd, and the system would be augmented, as necessary, at the end of 25 years to provide a total capacity of 100 mgd. Generally, the initial increment would consist of a 72-inch pipeline, and the pumps necessary for a 50 mgd demand. At the end of 25 years, using the same pipeline, pumping capacity would be stepped up to 100 mgd. As will be seen in table 5-19, the average annual costs for an ultimate demand of 100 mgd are about $475,000. This is a cost of about $0.013 per thousand gallons or about $4,750 per year per mgd.

17. DEVELOPMENTAL COSTS

The term "developmental costs" refers to the associated costs incurred to realize the developmental expansion benefits. These costs include investments undertaken by public and private enterprise and the cost of staffing, operation, maintenance and replacement of the facilities required to continue the associated activities.

TABLE 5-14
SUMMARY OF FIRST COST

CLINCHFIELD MULTIPLE PURPOSE RESERVOIR PROJECT
(December 1967 prices) $1,000 units

ITEM	COST	COST W/INDIRECTS DISTRIBUTED
Lands and damages	10,080	10,080
Relocations	2,817	3,135
Reservoir	3,246	3,613
Dam and appurtenances	12,672	14,101
Recreation facilities	24,414	27,168 (a)
Permanent operating equipment	240	267
Buildings, grounds and utilities	181	201
Engineering and design	1,743	
Supervision and administration	3,172	
TOTAL PROJECT COST	58,565	58,565

(a) Of this amount $2,789,000 is for initial facilities and $24,379,000 is for future facilities.

TABLE 5-15

DETAILED ESTIMATE OF FIRST COST
CLINCHFIELD MULTIPLE-PURPOSE RESERVOIR PROJECT
(December 1967 Prices)

Item	Unit	Quantity	Unit Price	Amount (1,000)
LANDS AND DAMAGES (See Table 5-8)				
Land	Acre	44,000	$134.00	$5,912
Improvements	Set	303		1,515
Severance	L.S.			540
Resettlement	L.S.			170
Acquisition costs	L.S.			263
Contingencies (20%)				1,680
TOTAL, LANDS AND DAMAGES				$10,080
RELOCATIONS				
Roads (state & county)	Mile	6.8		$ 487
Bridges	Each	3		720
Sewage treatment plant	Each	1		250
Gas Line	Lin Ft.	15,000		200
Power Lines	L.S.			110
Dike	Lin Ft.	7,000		420
Demolition	L.S.	1		30
Cemetaries	Grave	1,300	100.00	130
Contingencies (20%)				470
TOTAL, RELOCATIONS				$ 2,817
RESERVOIR				
Clearing & grubbing	Acre	7,425	350.00	$ 2,599
Clearing	Acre	1,350	60.00	81
Archaeological survey and salvage	L.S.1/			25
Contingencies (20%)				541
TOTAL, RESERVOIR				$ 3,246
DAM AND APPURTENANCES				
Dam and spillway				
Clearing & grubbing, construction, and work areas	Acre	150	350.00	$ 52.5
Stripping	C.Y.	80,000	0.60	48
Access road & railroad	L.S.	1		208

1/ Funds to be provided and studies to be made by the National Park Service during advanced planning.

TABLE 5-15 (cont'd)

Item	Unit	Quantity	Unit Price	Amount (1,000)
Dam and spillway (cont'd)				
Field Office	L.S.	1		20
Stream diversion & care	L.S.	1		1,300
Excavation, spillway, common	C.Y.	303,000	$ 0.35	106
Excavation, spillway, rock	C.Y.	91,000	2.25	205
Excavation, earth borrow	C.Y.	2,680,000	0.40	1,072
Excavation, rock, borrow	C.Y.	212,000	2.35	498
Fill (rolled)	C.Y.	3,090,000	0.08	247.2
Upstream sand blanket	C.Y.	29,600	7.50	222
Upstream rock & rock toe	C.Y.	303,000	6.00	1,818
Topsoil & seeding	Acre	40	1,250.00	50
Grouting & foundation preparation	L.S.	1		206
Concrete-weir (mass)	C.Y.	18,000	25.00	450
Concrete-weir (reinf)	C.Y.	1,800	40.00	72
Cut-off trench	C.Y.	31,000	1.50	46.5
Bank & channel Protection (spillway)	L.S.	1		1,620
Tainter gates & gate operating machinery	L.S.	1		490
Stone gutters	L.S.	1		28.75
Contingencies (20%)				1,752
Total, Dam and Spillway				$10,511.95
Outlet Works				
Excavation, unclassified	C.Y.	33,000	2.00	66
Concrete-conduits	C.Y.	7,780	60.00	467
Entrance & exit walls and Riprap	L.S.	1		80
Outlet gate house, gates, machinery, multi-level features, complete	L.S.	1		1,150
Stilling basin	L.S.	1		37
Contingencies (20%)				360
Total, Outlet Works				$2,160
TOTAL, DAM AND APPURTENANCES				$12,672

TABLE 5-15 (cont'd)

Item	Unit	Quantity	Unit Price	Amount (1,000)
RECREATION				
Initial development				
Facilities cost	L.S.			2,072
Contingencies				434
Total, Initial Development				$2,506
Future development				
Facilities Cost	L.S.			$18,257
Contingencies				3,651
Total, Future Development				$21,908
TOTAL, RECREATION				$24,414
PERMANENT OPERATING EQUIPMENT				
Precipitation stations	Each	3	$900.00	$ 2.7
Office equipment L.S.	L.S.			2.5
Shop equipment	L.S.			10
Diesel-electric generator	Each	1		15
Instrumentation, stream stage, & water quality	L.S.			20
Radio communication facilities	L.S.			7.5
Stream gaging stations	Each	3	14,000.00	42
Transportation, reservoir and ground maintenance equipment	L.S.			85
Floating plant	L.S.			5.3
Sedimentation ranges	L.S.			10
Contingencies (20%)				40
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 240
BUILDINGS, GROUNDS, AND UTILITIES				
Administration building	L.S.	1		$ 50
Three-bedroom residences	Each	2	20,000.00	40
Site work, clearing & grading	L.S.			20
Utilities	L.S.			10

TABLE 5-15 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
BUILDINGS, GROUNDS, AND UTILITIES (Cont'd)				
Maintenance Buildings	L.S.			$ 30,000
Contingencies (20%)				31,000
TOTAL, BUILDINGS, GROUNDS, & UTILITIES				$ 181,000
ENGINEERING AND DESIGN				
Initial Development	L.S.			$ 867,000
Future Increment	L.S.			876,000
TOTAL, ENGINEERING AND DESIGN				$1,743,000
SUPERVISION AND ADMINISTRATION				
Initial Development	L.S.			$1,577,000
Future Increment	L.S.			1,595,000
TOTAL, SUPERVISION AND ADMINISTRATION				$3,172,000

TABLE 5-16
SUMMARY OF FINANCIAL ANNUAL COST

CLINCHFIELD MULTIPLE PURPOSE RESERVOIR PROJECT

Item	
Interest on gross investment	$1,490,000
Amortization of gross investment	63,000
Maintenance and operation	722,000
Major replacements	141,000
TOTAL	$2,416,000

TABLE 5-17
DETAILED ESTIMATE OF FINANCIAL ANNUAL COST
CLINCHFIELD RESERVOIR

Item	Financial (1,000)
Total Investment - Initial Project	
(1) Recapitulation of project costs	
(a) Total net costs	$34,186
(2) Interest during construction 3¼% for ½ construction period 3 years (4.875%)	1,667
(3) Total gross investment	35,853
Annual Charges	
(1) Interest on gross investment	
(a) Financial: (0.325) (35,853,000)	1,165
(2) Amortization on net investment	
(a) Financial: (.00138) (35,853,000)	49
(3) Maintenance and Operation	
(a) Dam and reservoir	71
(b) General recreation and fish and wildlife recreation	192
(c) Wildlife mitigation measures	4
(4) Major replacements	
(a) Dam and reservoir	41
(b) General recreation and fish and wildlife recreation	23
(c) Wildlife mitigation measures	1
(5) Total initial annual charges	$1,546
Future Recreation Increment	
(1) Interest on gross investment	
(a) Financial: (.0325) (24,379,000) (.4104)	325
(2) Amortization	
(a) Financial: (.00138) (24,379,000) (.4104)	14
(3) Maintenance and operation	
(a) General recreation	455
(4) Major replacement	
(a) General recreation	76
(5) Total future recreation increment	$ 870
Total Annual Charges	$ 2,416

TABLE 5-18

DETAILED ESTIMATE OF LAND AND DAMAGES COST
CLINCHFIELD RESERVOIR

Item	Unit	Quantity	Unit Price	Amount (1,000)
RESERVOIR LANDS				
Land	Acre	36,000	$140.00	$5,040
Improvements	Set	260		1,350
Severance	L.S.			450
Resettlement	L.S.			135
Acquisition Costs	L.S.			225
Contingencies (20%)				1,440
Subtotal, Lands & Damages				$8,640
ADDITIONAL RECREATION LANDS				
Land	Acre	4,000	$140.00	560
Improvements	Set	30		150
Severance	L.S.			50
Resettlement	L.S.			15
Acquisition Costs				25
Contingencies (20%)				160
Subtotal, Lands and Damages				960
WILDLIFE DAMAGE MITIGATION LANDS				
Land	Acre	4,000	$ 78.00	312
Improvements	Set	3		15
Severance	L.S.			40
Resettlement	L.S.			20
Acquisition Costs	L.S.			13
Contingencies (20%)				80
Subtotal, Lands and Damages				480
TOTAL LANDS AND DAMAGES				$10,080

TABLE 5-19

ASSOCIATED PROJECT COSTS FOR CONSTRUCTION AND OPERATION OF SYSTEM FOR CONVEYING WATER FROM CLINCHFIELD RESERVOIR TO SPARTANBURG INTAKE ($1,000)

PROJECT COSTS (Undiscounted)	First Stage Constructed 1980 50 mgd	Second Stage Constructed 2005 100 mgd	
Pipeline, installed	5,500	no addition	
Pumping stations	800	1,600	
Lands and easements	50	no addition	
Contingencies (20%)	1,270	320	
Total construction costs	7,620	1,920	
Engineering and Design (4%)	305	77	
Supervision and Administration (7%)	555	140	
Total project investment costs	8,480	2,137	
ANNUAL COSTS (Discounted)[1]			Total Over Project Life
Interest and amortization	262	19	281
Major Replacement	6	5	11
Operation and Maintenance	22	12	34
Energy (pumping) costs	67	69	136
Insurance	9	4	13
Total annual costs	366	109	475

1. Annual costs have been discounted to place them on a common time datum with project annual costs. An assumed local government rate of 5 percent was used for discounting.

The developmental costs associated with the increased water supply (100 mgd) for Spartanburg County consist of the associated capital investment in new plant and equipment required for the incremental manufacturing employment. The incremental manufacturing employment during the period 1980-2020 is projected at 49,022. Using an average investment per employee of $11,000, the total required investment is $539,000,000. This is to be made over a 40-year period at the rate of $13,475,000 per year. Considering the present to be the year 1970, and discounting the initial investment and subsequent maintenance and replacement expenditures at a social rate of 3¼ percent; then computing interest and amortization charges at a private rate of 5 percent, results in equivalent annual charges of $16,579,000.

The developmental costs associated with recreational investment indicated by recreational expenditures totals about $11,000,000, with annual interest, amortization, maintenance, and replacement charges amounting to about $441,000. These figures are applicable to the total visitation. However, since in computing the development expansion benefits, only visitation originating from points more distant than 75 miles has been assumed to yield a net income gain to the Appalachian Region, only the costs associated with this visitation are to be counted here. Estimates of BOR indicate that, at maximum development, 20 percent of all visitation will originate at such distances, and that the average expenditure per (such) visitor would be about $4.00. This amounts to about half the total visitor expenditure. Accordingly, the relevant associated recreational investment would be about $5,530,000, and the annual charges about $220,000. Developmental costs are summarized in table 5-20.

TABLE 5-20

DEVELOPMENT COSTS ASSOCIATED WITH CLINCHFIELD RESERVOIR, N. C. ($1,000)

Item	Investment Costs	Annual Charges
Water Supply-related manufacturing investment, Greenville-Spartanburg Growth Center	$539,000	$16,579
Recreation industry investment associated with expenditures of non-Appalachian visitors (by private sector)	5,530	220
Associated project cost for distribution system	10,617	475
TOTAL	$555,147	$17,274

18. SUMMARY

The reservoir and developmental investment anticipated to follow the construction of the reservoir would provide benefits to users of project goods and services to the nation and to the Appalachian Region from the subsequent income expansion. User benefits may accrue to the nation only if users are located outside of the Appalachian Region. Following paragraphs of this section describe the procedures and assumptions used to measure the various classes and kinds of benefits. Table 5-21 summarizes these benefits by category and according to the national and/or regional account.

TABLE 5-21

SUMMARY OF BENEFITS
CLINCHFIELD RESERVOIR, NORTH CAROLINA

	Annual Benefits ($1,000)				
Item	Nat'l Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefits					
Flood Control	37		53	90	53
Water Supply			1,053	1,053	1,053
Water Quality Control	253			253	
Recreation	679		2,714	3,393	2,714
Total	969		3,820	4,789	3,820
Expansion Benefits					
Redevelopment		565	166	166	731
Developmental		4,479	112,829	112,829	117,598
Total		5,044	112,995	112,995	118,329
Total Benefits	969	5,044	116,815	117,784	122,149

19. USER BENEFITS

Benefits to users would accrue from the flood control, water quality control, water supply, and recreation features of the project. The regulation provided by Clinchfield Reservoir will provide some additional

hydroelectric power benefits to existing hydroelectric plants located downstream on the Broad and Santee Rivers. In accordance with current policy, the Corps of Engineers will supply the Federal Power Commission operating data for releases and FPC will calculate benefits to licensed hydroelectric plants downstream and make appropriate charges. The additional benefits are considered to be incidental and were not estimated for this report. For all practical purposes, all users, except a small number of recreation users, are located within the Appalachian Region. User benefits are estimated by various methods to approximate the value that users would be willing to pay for the goods and services provided by the project.

Flood Control

The reduction in flood damages to current and anticipated future development along Broad River is considered a user benefit accruing to the Clinchfield Reservoir project from the flood control storage space provided and from reservoir operation procedures. Damages prevented to future development is exclusive of project-induced development and assumes that development of the flood plain will continue to be based on the same precision and completeness of information that has been historically available. Thus, we assume neither highly restrictive flood plain information and zoning practices, nor deliberately stimulated flood plain development.

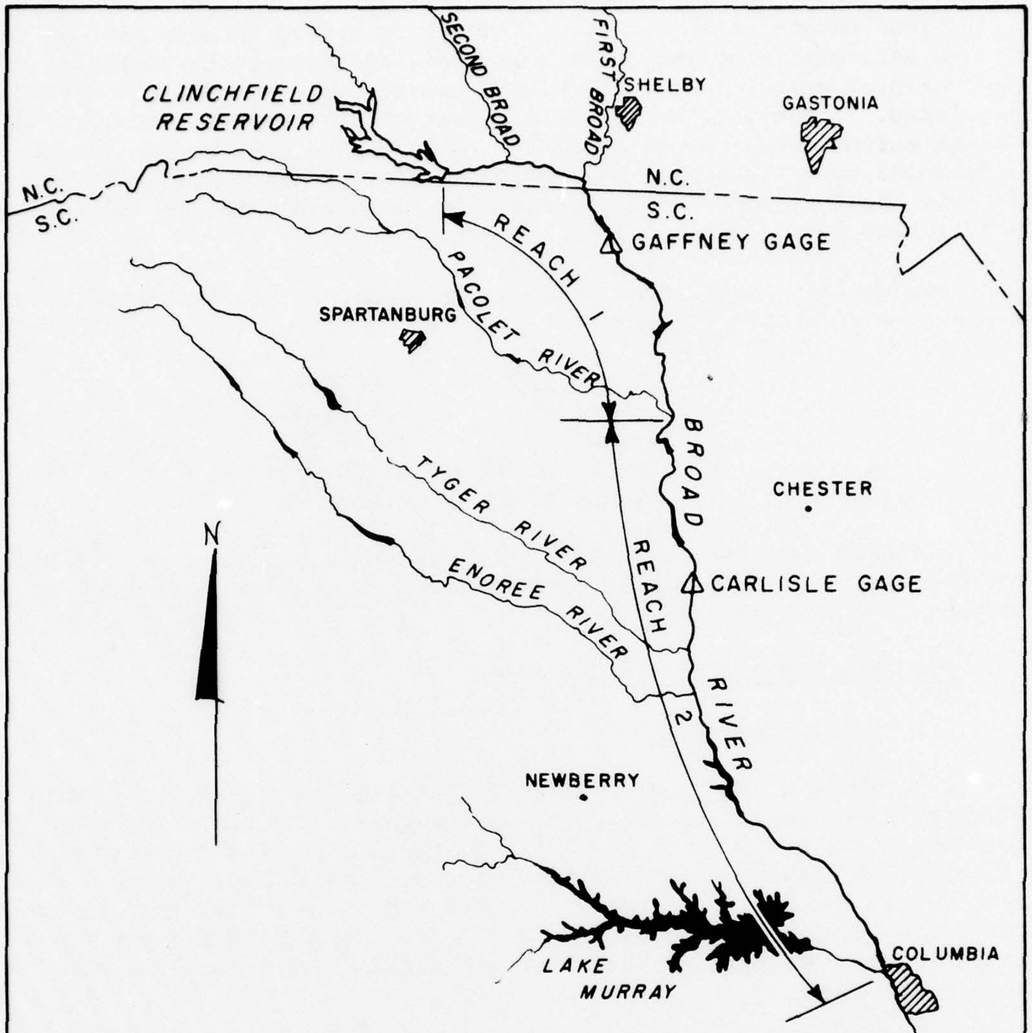
The anticipated increase in land values associated with improved land use capability is included in flood control benefits as enhancement. The gains do not include damages prevented under the enhanced land use.

Extent and Character of the Flooded Area

The flood plain area, between Columbia and Clinchfield Reservoir, contains two small urban developments (Lockhart and Peak), several small rural communities with populations less than 75, about 7,000 acres of agricultural lands, six hydroelectric power developments, and various transportation routes. The major transportation route located in the flood plain is the Southern Railway which follows the river between the mouth of the Tyger River and Columbia. There are 15 highway and six railroad bridges spanning the Broad River below Clinchfield.

Flood Damages

Data used to develop flood damage estimates were based on previous surveys and a cursory field examination to obtain current flood plain development. For study purposes, the river was divided into two reaches as shown on exhibit 5-14. Flood height reductions are at their maximum immediately below Clinchfield Reservoir and progressively diminish downstream as the uncontrolled drainage area increases.



REACH NO	DESCRIPTION	INDEX STATION
1	FROM CLINCHFIELD RESERVOIR TO PACOLET RIVER.	GAFFNEY GAGE
2	FROM PACOLET RIVER TO MOUTH OF BROAD RIVER	CARLISLE GAGE

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

FLOOD DAMAGE REACHES & INDEX STATIONS

BROAD RIVER, N.C & S.C.

SCALE
NO SCALE

Drawn by: W H D
Checked by: J.F.R
Approved: [signature]
Title: Chief, Proj Plan Br
Date: February 1968

EXHIBIT 5-14

Flood damage estimates are difficult to obtain because most of the damage estimates reported in the news media and reports by various governmental agencies cover the major damage centers and large urban complexes. Since neither of these appear along the Broad River, flood damage estimates except those of a cursory nature must be obtained by a detailed investigation. The estimated flood damages and benefits used in this study are conservative, and only those evaluated in sufficient detail have been claimed.

Damage from past floods are available only for the entire Santee Basin. These are as follows:

August 1908	-	$1,140,000
July 1916	-	1,840,000
August 1928	-	2,420,000
October 1929	-	2,400,000
August 1940	-	1,580,000

Although damage estimates are not available for the Broad River alone for these floods, they can be used as indicators of the relative severity of past floods in the basin.

Property Subject to Flood Damages

Urban Properties

There are no large cities on the Broad River above Columbia situated close enough to the river to experience periodic flooding. However, there are several small communities that are subject to some flooding. A detailed damage survey of these communities has not been made. One community, Lockhart, has several blocks of residential and commercial property situated behind a levee. Should this levee fail, there is the potential of severe property damage and possibly even the loss of life.

Industrial Properties

There are several industrial plants located along the river below Clinchfield Reservoir. Most of these have their facilities located at sufficient distances and elevation from the river not to be subject to flood damages. But some have facilities such as water supply systems, water treatment ponds, etc., that are close to the river and are subject to flood damage. Two textile mills located at Cherokee Falls and Lockhart have their entire facility located adjacent to the river.

Hydroelectric and Steam-Generating Plants

All of the hydroelectric plants located below Clinchfield are old, run-of-river plants. The first one, Neal Shoals, was constructed in 1905, and the last one was completed in 1927. Each of these are subject to various degrees of flood damage such as erosion, replacement

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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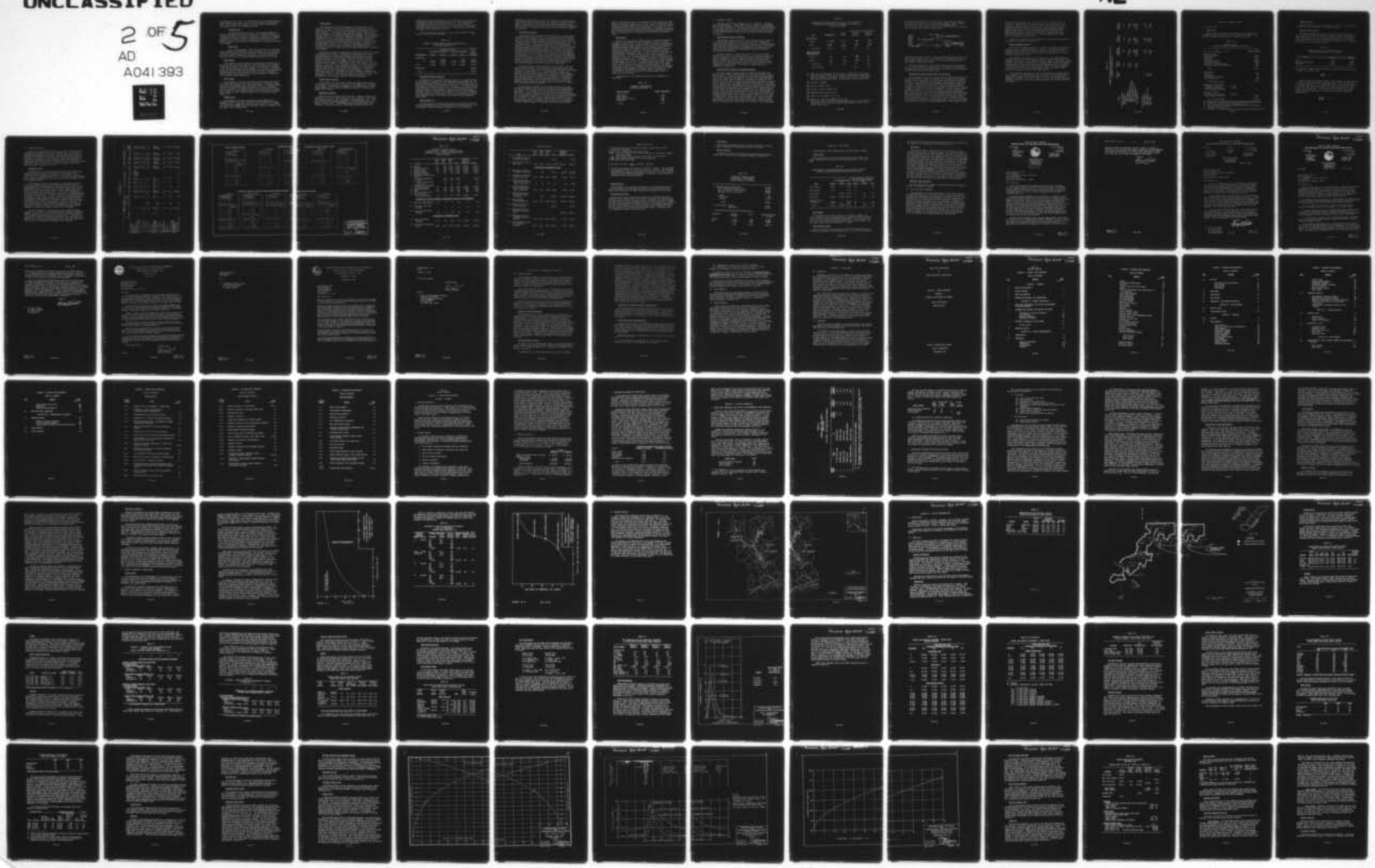


of flashboards, etc. Two of the hydro-plants also have steam-generating plants associated with them. One large (249,000 KVA) steam-generating plant, owned by Duke Power Company, is located along the Broad River just below the mouth of the Second Broad River.

Transportation

Low member elevations for most of the existing Highway and Railroad bridges are above the elevations for the floods of record. No bridges were washed out during the 1940 flood. Periodic flood damages are generally limited to erosion of abutments and approaches. Southern Railroad's track, which follows the Broad River for about 34 miles between Columbia and the mouth of the Tyger River, is subject to periodic flood damages.

Agriculture

There is approximately 19,000 acres of land in the flood plain between Columbia and Clinchfield. About one-third of this is currently being used for pasture and cultivated crops. The major crops produced are corn, soybeans, watermelons, and silage. Most of the fields are less than 100 acres, but a few are between 300 and 500 acres in size.

Urban Damage

Flood damages to urban properties were determined by estimating the amount and kind of property located in the flood plain that is subject to periodic flooding. No detailed field surveys were made to determine floor elevations and points of zero damage. An inventory of properties located on the flood plain were ascertained from maps, aerial photographs, telephone inquiries, and an inspection trip to the area. Damages to these properties were estimated for various elevations of flooding and used to develop stage-damage curves.

Rural Damage

Flood damages to crops were estimated by determining land use and then estimating losses to each crop, accounting for seasonality, depth, and duration of inundation for various flood events. A composite damage value was developed which weighs the effects of time of occurrence, duration, and depth of flooding on various crops typical for the flood plain. Damage to other rural property in the flood plain was estimated and combined with these composite values into a rural property stage-damage curve.

Damage Curves

Stage-damage curves were constructed for each damage zone by aggregating losses to property located in the flood plain over a range of flood stages. Damages were related to the elevation of the Gaffney and Carlisle stream gages which are considered typical of stages in damage zones 1 and 2, respectively.

Future Growth

The damages prevented for development of the flood plain in the future are credited to benefits to the project, when limited to the degree of development which could be anticipated in the absence of Clinchfield Reservoir. It is assumed that investors in flood plain development are rational in considering the risk from flooding. Their rational behavior depends on the degree of information available to them concerning flooding risks. Since flood plain development resulting from deliberate stimulation cannot be legitimately credited as benefits, deliberate actions to proscribe flood plain development by fiat on any basis other than expected economic risk would also be inadmissible. Therefore, normal developmental trends on the flood plain representing neither kind of overt action outlined above, and based on the expected level of information available to industries in flood plain development was assumed to be relevant.

Agricultural damages are expected to increase with projected increases in real agricultural output. Urban damages are expected to increase proportionately with projected increases in urban population, and to increase as higher incomes permit increased acquisition of improved household appliances and furnishings. Factors to be used for determining the future increment of damages for both urban and rural subdivisions were developed for Sub-region D in the "Main Report - Part III - Chapter 6 - Page III-6-81." These were 0.569 and 2.12 for rural and urban damages, respectively. These assume normal growth. It is anticipated that the flood plain area below Clinchfield Reservoir will experience somewhat less than the normal growth of the sub-region. Therefore, lower values were used to determine the future increment of damages for Clinchfield Reservoir. These were 0.33 and 0.7 for rural and urban values, respectively. These factors times the damages prevented to current development give the damages prevented to future development.

Average Annual Benefits

Flood damages, by stage, were converted to average annual values by multiplying the frequency of occurrence for each stage times the damage of the stage to weigh damage by probability. The difference in average annual damages with and without Clinchfield Reservoir is credited as a benefit to the project.

Enhancement Benefits

Reduced flooding hazards permit land uses to change to higher, more productive uses for both agricultural and urban situations. The changes in productive capability are capitalized in increased land values. This gain is distinct from damages prevented to current land uses and incremental to future growth. Enhancement benefits are deliberately sought increases in land-use capability. Enhancement benefits credited to

Clinchfield Reservoir are estimated to be $16,000 annually and primarily attributable to improved land-use capability for agricultural uses. Clinchfield Reservoir provides standard project flood protection to areas immediately below the reservoir and a high degree of protection to additional areas several miles downstream. There is about 2,500 acres of potential idle farmland in reach 1.

Table 5-22 presents a summary of flood control benefits by damage zones for the Clinchfield Reservoir.

TABLE 5-22

SUMMARY OF AVERAGE ANNUAL FLOOD CONTROL BENEFITS ($)
CLINCHFIELD RESERVOIR, N. C.

	Damages Prevented				Total
	to Current Development		to Future Development		Flood Control
Stream/Reach	Urban	Rural	Urban	Rural	Benefits
Broad River					
1		15,000		4,900	19,900
2	10,000	28,000	7,000	9,100	54,100
Total	10,000	43,000	7,000	14,000	74,000
Enhancement					16,000
Total					90,000

Recreation Benefits (General)

An analysis of the general recreation potential of Clinchfield Reservoir was made by the Bureau of Outdoor Recreation (see Appendix F). Ultimate attendance is estimated to be 5,700,000 recreation days annually, with initial attendance at one-tenth of this level. The benefit value per recreation day is estimated to be $1.25. Drawdown on the recreation pool is not expected to create serious conflicts with recreational use of the reservoir, except at rare intervals. Annual benefits for the general recreation use of the reservoir is estimated to be $3,172,000 (5,700,000 x $1.25 x 0.4452), the latter factor being one that reduces the benefits to an equivalent annual value based on an assumed normal exponential growth curve.

Fish and Wildlife

The Fish and Wildlife Service evaluated the potential for fish and wildlife enhancement of the Clinchfield Reservoir (see Appendix G). The net increase in fisherman-days is estimated to be 217,500 annually

resulting in annual benefits of $221,000 (rounded). Losses in hunting opportunities would be mitigated by the acquisition of 4,000 acres (at project cost) adjacent to the Green River Wildlife Management area, which is owned in fee by the North Carolina Wildlife Resources Commission. This unit would be licensed to the State of North Carolina and managed by the State.

Water Quality Control

Using seasonal low flow objectives supplied by the Federal Water Pollution Control Administration, it was calculated that about 90,000 acre-feet of water quality storage in Clinchfield Reservoir could mitigate a pollution problem occurring on the Broad River, just below the confluence with its acolet River tributary, during periods of low flow on the Broad River. This problem would result from Spartanburg's discharge of wastes (treated to 85% BOD removal) into the Pacolet about 30 miles upstream from the Broad. Hence, the whole problem consists of clearing up pollution in about 30 miles of the Pacolet, and reach of the Broad exerting a heavy oxygen demand due to Pacolet-borne wastes. Stream quality in this 30-mile reach of the Pacolet can be improved by two basic means: (1) by a pipeline conveying the wastes from Spartanburg along the Pacolet, and discharging into the Broad, which moves the locus of the problem to the Broad, and (2) by clearing up the pollution problem in the Pacolet by means of (a) advanced waste treatment, or (b) flow augmentation from a reservoir on the North Pacolet, which concurrently eliminates the problem area on the Broad River.

To maintain desired oxygen standards in both streams, there are three alternate methods: (1) advanced waste treatement (annual cost $681,000), (2) flow regulation by a single-purpose reservoir on the North Pacolet near Fingerville, S. C. (currently estimated annual cost $565,000), and (3) piping wastes to the road River and flow regulation (on the Broad) from a single-purpose reservoir at the Clinchfield site (currently estimated annual cost - $988,000), or $312,000 and $676,000 respectively. The single-purpose reservoir at Clinchfield would store 90,000 acre-feet for water quality control, while, for comparable effectiveness in the Broad River, the reservoir at Fingerville would store 116,900 acre-feet.

In evaluating the benefits of the 90,000 acre-feet of storage provided for quality control in the Clinchfield multi-purpose project, one wishes to identify the lowest cost alternative for achieving the same result; i.e., elimination of the pollution problem area on the Broad River. Analysis indicates that the lowest cost alternate project is a single-purpose reservoir on the North Pacolet (annual cost $565,000), but this differs in effect by also clearing the problem area on the Pacolet River. Since the problem in both streams could be cleared by an annual expenditure of $565,000, then the benefit value assigned to the water quality storage at Clinchfield must be such that it (the

benefit value) and the cost of any remaining feasible measures for eliminating the pollution problem in the Pacolet should not exceed $565,000. That is, an equitable benefit value for the storage at Clinchfield should be $565,000 less $312,000, or $253,000 annually. This stems from the fact that the lowest cost means of eliminating the problem on the Pacolet, after providing storage at Clinchfield to cope with the Broad River problem, is the construction of a pipeline from Spartanburg to the Broad River.

Water Supply

The value of water supply storage placed in Clinchfield Reservoir is related to "willingness to pay" by seeking the cost of the most economical alternate source of water supply of comparable dependability. The projected water supply demands of the area that could be served by Clinchfield indicate that during the period 1980-2020 a need for an additional 715 mgd could develop. When this is considered along with current trends towards construction of larger distribution systems requiring sources of greater yield, the yield of about 443 mgd provided by the storage of 716,000 acre-feet of water supply storage in the Clinchfield site - the only practicable site in the environmental area capable of such yield - the Clinchfield site appears to become the most economical alternate source. Accordingly, the value of the water supply has been taken to be the cost of a single-purpose water supply reservoir at the Clinchfield site, with a storage of 716,000 acre-feet of water supply, as well as 26,500 acre-feet of sediment storage. The project cost of such a reservoir is estimated at $27,746,000, and the investment (including interest during the assumed three-year construction period) is estimated at $29,099,000. The annual costs are estimated at $1,053,000, and these are taken to be the annual benefit value, to users, of the water supply.

User benefits for the Clinchfield Reservoir are summarized in table 5-23.

TABLE 5-23

SUMMARY OF USER BENEFITS
CLINCHFIELD RESERVOIR, N. C.

Type of Benefit	Amount ($1,000/yr)
Flood Control	90
Water Supply	1,053
Water Quality Control	253
Recreation	3,393
Total	4,789

20. EXPANSION BENEFITS

Expansion benefits are developed into two categories: redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation, and maintenance of the water resource plan. Developmental benefits are measured in terms of wage payments made to persons not directly associated with the project, but whose employment results from the economic activity induced by the project.

Redevelopment Expansion Benefits

Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor use in the construction, operation, and maintenance of the water resource plan. Benefits credited to the national account consist of the wage payments made to persons who would otherwise be unemployed or underemployed in the absence of the project and who possess the necessary skills required for project construction and operation.

Detailed analysis of construction costs to various reservoirs indicate labor costs to be about 20 percent of construction costs, less lands and damages and about 70 percent of annual operation and maintenance expenditures. Further analysis was made to determine the degrees of skill required for project construction and operation and what portion of these labor skills could be furnished from the locally unemployed or underemployed. The results of these studies are presented in table 5-24.

Additional Water Supply to Spartanburg County

The water supply storage included in Clinchfield Reservoir will provide about 443 million gallons per day additional dependable yield to potential users. A lack of development of water supply for Spartanburg County would constrain development of the Greenville-Spartanburg Growth Center after 1980. When the demand is projected and compared to that expected to be supplied by presently planned system expansions, it appears that the increase in water supply would be absorbed during the 40 years between 1980 and 2020. Benchmark projection of population for Spartanburg County indicates that the population would increase by about 442,500, and that manufacturing employment would increase by about 49,000 during this period. Using an income of about $3,800 per job, the increased annual income after the 40-year developmental period would be $186,300,000. The estimated employment multiplier effects of this change in manufacturing employment would indicate total income changes in the area on the order of $402,400,000. The average annual equivalent of this gain is assumed to represent net regional and national income gains. Regional income gains would include these gains plus transfers from outside Appalachia, which are estimated to be on the order of 15 percent of total wage gains.

TABLE 5-24

REDEVELOPMENT EXPANSION BENEFITS BASED ON LABOR EMPLOYED IN CONSTRUCTION, OPERATION AND MAINTENANCE OF CLINCHFIELD PROJECT ($1,000) 1/

Item	Expenditure	Labor Costs	Annual Redevelopment Benefits National Account	Annual Redevelopment Benefits Regional Account
Construction				
Initial	21,662 2/	4,332	72 5/	147 3/
Future	21,908	4,382	39 5/	78 4/
Sub-Totals	43,570	8,714	111	225
Annual Operation and Maintenance				
Initial	267	187	29 6/	187
Future	455	319	26 7/	319
Sub-Totals	722	506	55	506
Total Benefits			166	731

1/ Labor cost is estimated to be 20 percent of construction costs, less lands and damages; 70 percent of operation and maintenance expenditures. Period of analysis is 100 years. Interest rate is 3¼%. Locally-used labor during construction (49%), for maintenance and operation (55%).

2/ ($31,742 - $10,080)

3/ $4,332 x 0.03388 = $147

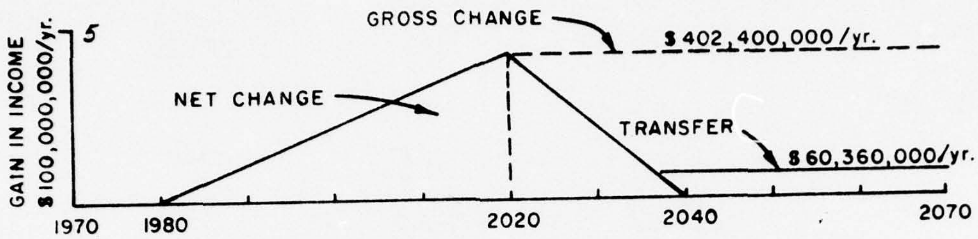
4/ $4,382 x 0.5275 x 0.03388 = $78

5/ Regional account value x 0.49

6/ $187 x 8.4 x 0.03388 x 0.55 = $29

7/ $319 x 8.4 x 0.5275 x 0.03388 x 0.55 = $26
(Where 8.4 = PW of uniformly decreasing annuity, from 1 to 0 in 20 yrs., at interest rate of 3¼%; and 0.5275 is single-payment present worth factor, 3¼%, 20 yrs.)

The following graph indicates the estimates of gross and net changes in income for both national and regional income accounts. The triangular area represents the net gain in national and **regional income.** The area to the right labelled "transfer" would be added to the triangular area to estimte the regional income account.



The average equivalent of gain to national income when discounted at 3-1/4 percent interest would amount to $113,015,000. The increment of gain to the regional income account would be $117,152,000 from the provision of water supply to Spartanburg County.

The above discussion of income gains associated with manufacturing use of the water supply in Clinchfield has been limited to an estimate of such gains accruing to Spartanburg County, since that county has expressed definite plans for using Clinchfield water.

Expenditures by Recreational Users of the Project

The recreational use of the reservoir and the associated recreational facilities will have an impact on incomes for the region and the nation. Assuming that the expenditures of recreation visitors would otherwise be saved, the total expenditure and employment stream thereby created would be a gain. Assuming all expenditures would be transferred or spent on substitutes, there would be no net gain. Bureau of Outdoor Recreation estimates of origin and visitation in Appendix F indicate that, at maximum originating 76 miles or more from the reservoir, and their expenditures have been considered to represent net receipt accruing to Appalachia. Since a multiplier was used on the income gains calculated for water supply, some double-counting would occur if all expenditures for recreation were counted as net gains. Thus, the expenditures of visitors more distant than 76 miles have been used to represent net gains in order to allow for these and previously-mentioned offsetting effects. Based on BOR estimates of visitation over 76 miles, average expenditures of such visitors should

total about $1,950,000 per year. About $736,000 of this will accrue in the form of wages and salaries to persons engaged in recreation-related businesses. Assuming that 49 percent of these wages and salaries accrue to persons who would otherwise be unemployed, and utilizing a 20-year linear cut-off, total wages accruing to the otherwise unemployed would be about $47,200 annually. Using the Rutherford County, North Carolina, employment multiplier to indicate the magnitude of total change would result in $103,500 net income benefits. This $103,500 would be a gain both to the nation and to the region.

A summary of expansion and user benefits for the Clinchfield Reservoir, by account, is presented in table 5-25.

Land Development Benefits

This class of expansion benefits is normally calculated as the increased income due to the increased industrial activity on land made flood-free, or otherwise made attractive to investors, because of the reservoir. That benefits of this nature can be expected has been recognized, but they have not been estimated explicitly.

Land adjoining the reservoir will doubtlessly be developed with more expensive homesites and containing more taxable personal property than those presently in the area. Local interests produced figures at the Public Hearing at Forest City, North Carolina (held on 3 January 1968), showing that making allowance for the lost tax revenues from the submerged lands, the counties of Polk and Rutherford should realize about $20,000 a year more residential tax revenue (at the same rate and assessment ratio). The shore of the reservoir is expected to attract some light industry.

Local interests also point out that if the Broad River is made flood-free, a number of good industrial sites are likely to be utilized along the bottomlands reaching about 16 miles below the damsite (in Cleveland and Rutherford Counties). This will be partly due to the increased freedom from flooding, and partly due to the increased dependable water supply furnished by the dam.

TABLE 5-25

SUMMARY OF EXPANSION AND USER BENEFITS ($1,000)
CLINCHFIELD RESERVOIR, N. C.

Item	National Only	Regional Only	National & Regional	Total National	Total Regional
Expansion Benefits					
Redevelopment		565	166	166	731
Development					
Water Supply - Spartanburg, S.C.		4,137	113,015	113,015	117,152
Recreation Expenditures		632	104	104	736
Offset from loss of income from reservoir lands			(290)	(290)	(290)
Total Development		4,479	112,829	112,829	117,598
Total Expansion		5,044	112,995	112,995	118,329
User Benefits					
Flood Control	37		53	90	53
Water Supply			1,053	1,053	1,053
Water Quality Control	253			253	
Recreation	679		2,714	3,393	2,714
Total User	969		3,820	4,789	3,820

SECTION VI - ECONOMIC ANALYSIS

21. ECONOMIC DATA

Project Cost

Annual charges were computed, utilizing data and developing cost estimates presented in Section IV of this chapter. A summary of costs for the Clinchfield Reservoir project is shown in Table 5-26.

TABLE 5-26

SUMMARY OF COSTS
CLINCHFIELD RESERVOIR AND ASSOCIATED INVESTMENT

Item		Amount ($1,000)
Construction Costs (1)		
Lands and Damages		$ 10,080
Relocations		3,135
Reservoir		3,613
Dam & Appurtenances		14,101
Recreation Facilities		27,168 (2)
Permanent Operating Equipment		267
Buildings, Grounds, and Utilities		201
Total		$ 58,565
Annual Charges		
Interest		1,490
Amortization		63
Maintenance and Operation		722
Major Replacements		141
Total, Project Costs		$ 2,416
Associated Project Costs (3)		
Investment, undiscounted	$10,617	
Investment, discounted	5,593	
Annual charges, discounted		475
Development Costs (4)		
Investment, undiscounted	$554,530	
Annual charges, discounted		16,799
Total, Annual Charges		$ 19,690

(1) Includes cost of engineering, design, supervision and administration.
(2) Includes $24,379,000 for future recreation facilities.
(3) Water conveyance system from Clinchfield Reservoir to Spartanburg's Lake Bowen (see table 5-19).
(4) Investment in manufacturing and recreational facilities (see table 5-20).

Project Benefits

Annual economic benefits, as developed in Section V, are summarized in table 5-27 for the national and regional accounts.

Indices of Performance

One index of performance which is related to economic efficiency can be evaluated by dividing benefits by costs as generally developed for water resource projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water project (redevelopment benefits). The denominator is the annual cost of the water project.

TABLE 5-27

SUMMARY OF BENEFITS FOR PERFORMANCE INDICES
CLINCHFIELD RESERVOIR, N. C. ($1,000)

Item	National	Regional
User	4,789	3,820
User and Redevelopment	4,955	4,551
Expansion	112,995	118,329

Such an index, computed below, expresses the minimum index of performance in regard to national income:

$$\frac{4,955}{2,416} = 2.1$$

Another index of performance gives a relative measure of the contribution that Clinchfield Reservoir development would make to the objective of expanding employment in the Appalachian Region. The numerator consists of increased wage payments for construction and operation of the water project plus wage and salary flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{118,329}{19,690} = 6.0$$

22. ALLOCATION OF COST

Costs of the Clinchfield Reservoir project were allocated by the separable cost remaining benefits methods modified to accommodate regional income expansion as a purpose. Purposes among which costs are allocated include flood control, water supply, water quality control, recreation, and regional income expansion. Table 5-28 summarizes the construction expenditures, annual operation, maintenance and major replacements costs, total capital and investment cost, and annual charges. Exhibit 5-15 shows the features of projects utilized in table 5-28. Cost allocation is given in table 5-29.

Alternative Costs

The SCRB method of cost allocation provides that allocated costs should be limited by the lower of either of the benefits of the alternative costs providing each purpose. The alternative cost for flood control, as summarized in table 5-28, was based on actual estimates for a single-purpose flood control project at the site selected for the multi-purpose reservoir.

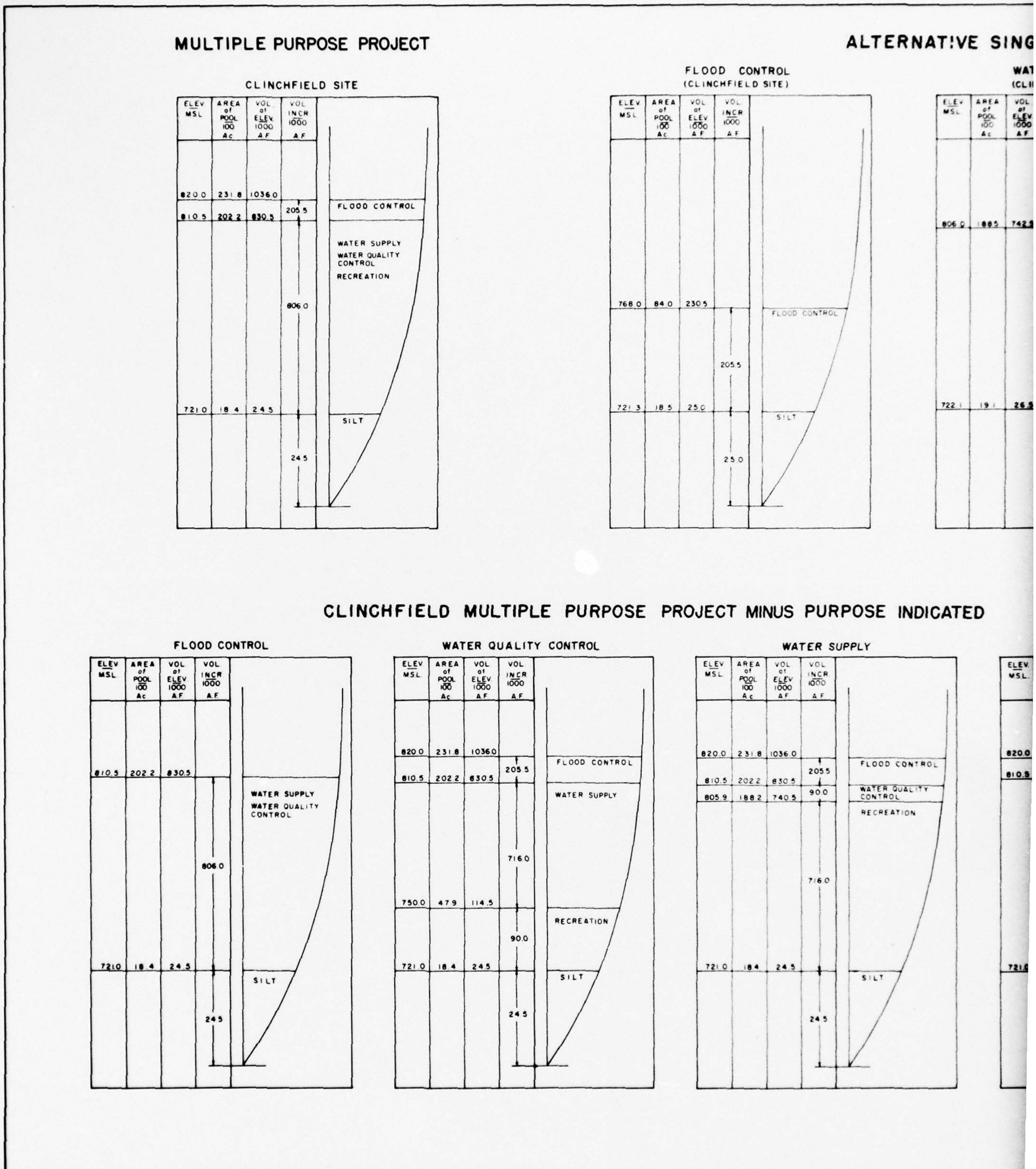
The alternative costs for recreation were developed from statistical data compiled by the Corps of Engineers reflecting costs of single-purpose recreation development undertaken by state parks in Ohio River Basin states. Alternative costs for water quality control were developed by the Federal Water Pollution Control Administration and given in Appendix D of the Main Report. The basis for estimation of alternative costs for water quality and water supply have been discussed previously in paragraph 19. It will be noted (in that paragraph) that, in the case of water quality control, the maximum justifiable benefits ($253,000) have been derived by subtracting a sewage pipeline from Spartanburg to the Broad River ($312,000), from the cost of the Fingerville (North Pacolet River) single-purpose reservoir ($565,000). It was considered that the actual physical alternative to water quality storage in Clinchfield consists of the single-purpose water quality reservoir at Fingerville, having an annual cost of $565,000.

The value assigned as an alternative cost for regional income expansion is not based on a relevant alternative program for providing similar income effects, because the full range for alternative means for obtaining these benefits have not been evaluated. To maintain the principal of the SCRB cost allocation procedure, the total cost of the water project, associated, and development costs have been entered as a limit on cost to be allocated to regional income expansion.

TABLE 5-28

SUMMARY OF COSTS ($1,000)
CLINCHFIELD PROJECT AND ASSOCIATED
INVESTMENT PLAN

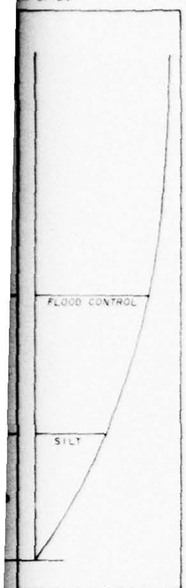
Item	MULTIPLE PURPOSE PLAN — Specific Use Lands and Facilities: Flood Control	Water quality	Recreation	Regional Income Expansion	Joint-use Land and Facilities (w/r project)	Total Costs	Alternate Single Purpose Projects: Flood Control	Water quality	Water Supply	Recreation	MULTIPLE PURPOSE PROJECT LESS: Flood Control	Water quality	Water Supply	Recreation	Regional Income Expansion
Construction First Costs:															
CLINCHFIELD PROJECT															
Lands and damages			960		9,120	10,080	4,813	3,579	8,123	Annual Costs	9,216	10,080	10,080	9,120	10,080
Relocations					3,135	3,135	2,140	1,469	2,761	below based	3,135	3,135	3,135	3,135	3,135
Res. and Pool Preparation					3,613	3,613	931	1,067	3,419	on equivalent	3,613	3,332	1,447	3,613	3,613
Dam and Appurtenances		334			13,767	14,101	12,106	7,727	12,975	state park	13,673	13,767	13,767	14,101	14,101
Recreation facilities (initial)			2,789		0	2,789	0	0	0	facilities	2,789	2,789	2,789	0	2,789
Bldgs., grounds, and utilities					201	201	201	134	201		201	201	201	201	201
Permanent operating equipment					267	267	267	250	267		267	267	267	267	267
TOTAL INITIAL		334	3,749		30,103	34,186	20,458	14,226	27,746		32,894	33,571	31,686	30,437	34,186
Future recreation facilities			24,379			24,379					24,379	24,379	24,379		24,379
TOTAL CLINCHFIELD PROJECT		334	28,128		30,103	58,565	20,458	14,226	27,746		57,273	57,950	56,065	30,437	58,565
Economic development plan				565,147		565,147					565,147	565,147	565,147	565,147	
TOTAL CONSTRUCTION COSTS		334	28,128	565,147	30,103	623,712	20,458	14,226	27,746		622,420	623,097	621,212	595,584	58,565
Investment Costs:															
CLINCHFIELD PROJECT															
Initial construction costs		334	3,749		30,103	34,186	20,458	14,226	27,746		32,894	33,571	31,686	30,437	34,186
Interest during construction		16	183		1,468	1,667	997	694	1,353		1,604	1,637	1,545	1,484	1,667
Investment, INITIAL INCREMENT:		350	3,932		31,571	35,853	21,455	14,920	29,099		34,498	35,208	33,231	31,921	35,853
Future recreation facilities			24,379			24,379					24,379	24,379	24,379		24,379
Economic development plan				565,147		565,147					565,147	565,147	565,147	565,147	565,147
TOTAL INVESTMENT COSTS		350	28,311	565,147	31,571	625,379	21,455	14,920	29,099		624,024	624,734	622,757	597,068	625,379
Annual Financial Charges:															
Initial Increment:															
Interest and amortization		12	133	17,274	1,069	18,488	730	506	986		18,443	18,467	18,400	18,366	1,214
Operation and maintenance															
Recreation			192			192					192	192	192	0	192
Dam					75	75					53	75	53	75	75
Major replacement							50	47	47						
Recreation			23			23					23	23	23	0	23
Dam					42	42	32	12	20		28	42	33	42	42
TOTAL INITIAL INCREMENT		12	348	17,274	1,186	18,820	812	565	1,053		18,739	18,799	18,701	18,472	1,546
Future Increment (discounted)															
Interest and amortization			339			339					339	339	339	0	339
Operation and maintenance			455			455					455	455	455	0	455
Major replacement			76			76					76	76	76	0	76
TOTAL FUTURE INCREMENT			870			870					870	870	870	0	870
TOTAL ANNUAL FINANCIAL CHARGES		12	1,218	17,274	1,186	19,690	812	565	1,053	2,518	19,609	19,669	19,571	18,472	2,416


MULTIPLE PURPOSE PROJECT
CLINCHFIELD SITE
ELEV MSL
AREA of POOL 100 Ac
VOL of ELEV 1000 A.F.
VOL INCR 1000 A.F.
820.0 231.8 1036.0
810.5 202.2 830.5
205.5
FLOOD CONTROL
WATER SUPPLY
WATER QUALITY CONTROL
RECREATION
806.0
721.0 18.4 24.5
SILT
24.5
ALTERNATIVE SING
FLOOD CONTROL
(CLINCHFIELD SITE)
768.0 84.0 230.5
FLOOD CONTROL
205.5
721.3 18.5 25.0
SILT
25.0
WAT
(CLI
806.0 188.5 742.5
722.1 19.1 26.5
CLINCHFIELD MULTIPLE PURPOSE PROJECT MINUS PURPOSE INDICATED
FLOOD CONTROL
810.5 202.2 830.5
WATER SUPPLY
WATER QUALITY CONTROL
806.0
721.0 18.4 24.5
SILT
24.5
WATER QUALITY CONTROL
820.0 231.8 1036.0
810.5 202.2 830.5
205.5
FLOOD CONTROL
WATER SUPPLY
716.0
750.0 47.9 114.5
RECREATION
90.0
721.0 18.4 24.5
SILT
24.5
WATER SUPPLY
820.0 231.8 1036.0
810.5 202.2 830.5
805.9 188.2 740.5
205.5
90.0
FLOOD CONTROL
WATER QUALITY CONTROL
RECREATION
716.0
721.0 18.4 24.5
SILT
24.5
820.0
810.5
721.0

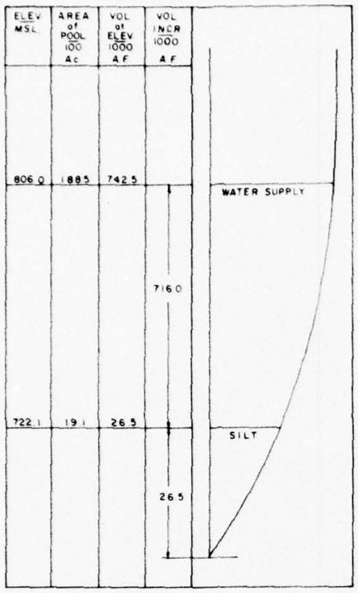
2

ALTERNATIVE SINGLE PURPOSE PROJECT

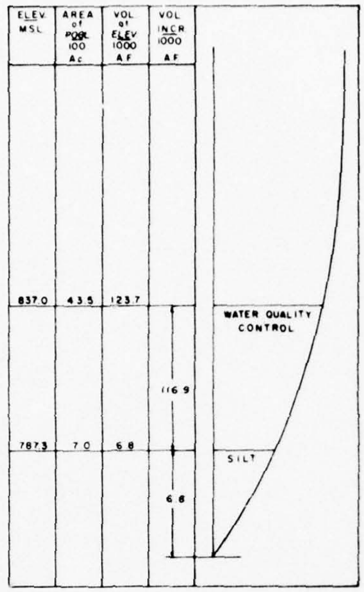
NTROL
D SITE)



WATER SUPPLY
(CLINCHFIELD SITE)

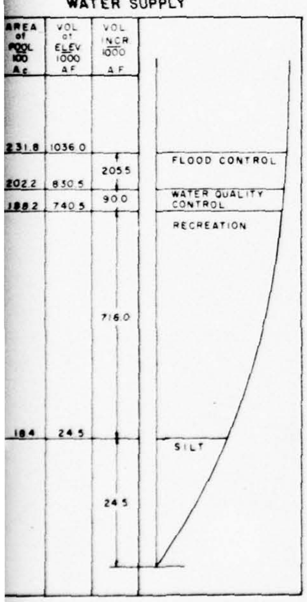


WATER QUALITY CONTROL
(FINGERVILLE SITE, PACOLET RIVER, S.C.)

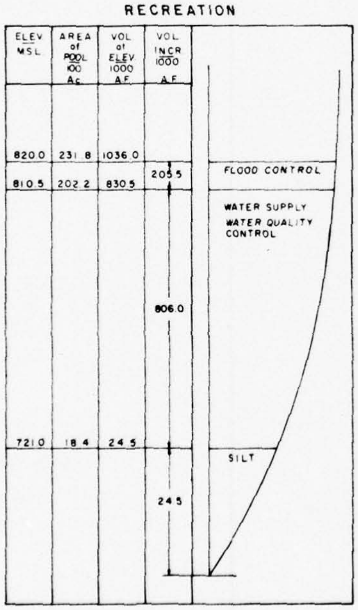


MINUS PURPOSE INDICATED

WATER SUPPLY



RECREATION



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CLINCHFIELD DAM SITE
PROJECT FEATURES
COST ALLOCATION STUDIES

SCALE
NO SCALE

Drawn by: W.H.D.
Checked by: J.A.N.
Approved: [signature]
Title: Chief, Proj. Plan. Br.
Date: March 1969

EXHIBIT 5-15

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TABLE 5-29

ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
CLINCHFIELD PROJECT ECONOMIC DEVELOPMENT PLAN
(North Carolina)

Item	Flood Con-trol	Water Qual-ity	Water Sup-ply	Rec.	Regional Expansion Effects	Total
1. Benefits	90	253	1,053	3,393	118,329	123,118
2. Alternative Costs	812	565	1,053	2,518	19,690	24,638
3. Benefit Limits	90	253	1,053	2,518	19,690	23,604
4. Separable Costs	81	21	119	1,218	17,274	18,713
5. Remaining Benefits	9	232	934	1,300	2,416	4,891
6. Allocation of Restricted Costs:						
a. Remaining Benefits		232	934	1,300		2,466
b. Ratio		.094	.379	.527		1.00
c. Allocated Restricted Costs (1)		23	93	130		246
7. Separable plus Allocated Restricted Costs	81	44	212	1,348	17,274	18,959
8. Remaining Benefits	9	209	841	1,170	2,416	4,645
9. Ratio	.002	.045	.181	.252	.520	1.000
10. Allocated Joint Costs	2	33	132	184	380	731
11. Total Allocated Financial Charges	83	77	344	1,532	17,654	19,690
ALLOCATION OF ANNUAL OPERATION, MAINTENANCE CHARGES, AND REPLACEMENT						
12. Separable OM&R Charges	36	0	31	746	0	813
13. Allocated Joint OM&R Charges		2	9	13	26	50
14. Total Allocated OM&R Charges	36	2	40	759	26	863
ALLOCATION OF INVESTMENT COSTS						
15. Annual Investment Charges	47	75	304	773	17,628	18,827
16. Capitalized Investment Costs	1,387	2,214	8,973	22,816	575,596	610,986

TABLE 5-29 (Cont')

Item	Flood Con- trol	Water Qual- ity	Water Sup- ply	Rec.	Regional Expansion Effects	Total
17. Adjustment for Discount on Future Increment				14,393		14,393
18. Total Allocated Investment Costs	1,387	2,214	8,973	37,209 3/	575,596	625,379
		ALLOCATION OF CONSTRUCTION COSTS				
19. Investment in Specific Use Lands & Facilities		350		28,311	565,147	593,808
20. Investment in Joint-Use Lands & Facilities	1,387	1,864	8,973	8,898	10,449	31,571
21. Interest during construction on Joint-Use Lands & Facilities	64	87	417	414	486	1,468
22. Allocated Construction Costs of Joint-Use Lands & Facilities	1,323	1,777	8,556	8,484	9,963	30,103
23. Construction Costs of Specific Use Lands & Facilities		334		28,128	565,147	593,609
24. Total Allocated Construction Costs	1,323	2,111	8,556	36,612	575,110	623,712
25. Construction Costs of Future Increment				24,379		24,379
26. Construction Costs of Economic Development Plan					565,147	565,147
27. Construction Costs of Clinchfield Reservoir (initial)	1,323	2,111	8,556	12,233	9,963	34,186
28. Total Construction Costs of Clinchfield Reservoir	1,323	2,111	8,556	36,612	9,963	58,565

TABLE 5-29 (Cont'd)

1/ Restricted joint costs of adding storage for water quality, water supply, and recreation.

\$19,690	Cost of multiple-purpose plan (\$1,000).
18,086	Cost of alternative flood control plan (\$812 + \$17,274 and economic expansion element.
1,604	Cost of adding water quality, water supply, and recreation.
1,358	Less assigned separable cost to these purposes.
\$ 246	Restricted joint costs.

2/ $(\$17,628 - \$17,274) \times \frac{1}{.03388} + \$565,147 = \$575,596.$

3/ (In \$1,000) investment allocated to recreation is \$37,209. The discounted (Present Worth) of this is: (\$37,209 - \$14,393) = \$22,816. The discounted investment for the water resource project is (\$60,232 - \$14,393) = \$45,839. Hence, discounted investment allocated to recreation is less than half of (discounted) total project investment.

Separable Costs

The incremental cost for adding each purpose to the multiple-purpose project was calculated by estimating the savings which would accrue if that purpose were omitted and all other purposes were maintained in the project.

Restricted Joint Cost

In the case of water quality, water supply, and recreation, the pool resulting from the storage allocation to the three purposes is jointly used by the three purposes, but not by flood control. Therefore, the cost of adding the total storage increment represented by these three purposes was calculated, the sum of the separable cost already allocated to each purpose subtracted from this gross incremental cost and the residual to be allocated to each of the three purposes in the ratio of the benefits remains. Restricted joint costs amounted to \$246,000 (see Table 5-29).

Joint Costs

Joint costs were allocated to each purpose according to the ratio of benefits remaining after separable costs were allocated.

Recreation Costs

The costs allocated to recreation have been sub-allocated between general and fish and wildlife recreation programs in table 5-30.

TABLE 5-30

CLINCHFIELD RESERVOIR PROJECT
RECREATION - APPORTIONMENT
BETWEEN FEDERAL & NON-FEDERAL

1. Separable Costs of Recreation	($1,000)
Cost of Multiple-Purpose Project	58,565
Cost of MP Project less Recreation	30,437
Separable Costs of Recreation	28,128
Lands	960
Facilities	27,168
Storage	0
Total	28,128
2. Cost Sharing - Federal	14,064
Non-Federal	14,064

Sub-Allocation Apportioned Recreation Costs

Recreation	Benefits ($1,000)	Ratio	Apportioned Costs ($1,000)
General	3,172	.935	34,232
F&W	221	.065	2,380
	3,393	1.000	36,612

SECTION VII - COST SHARING

23. APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

Flood Control

All costs allocated to flood control have been apportioned to the Federal Government in accordance with established policy. (See table 5-31).

TABLE 5-31

APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS
CLINCHFIELD RESERVOIR PROJECT, NORTH CAROLINA ($1,000)

Item	Construction Costs			Annual Operation, Maintenance and Replacement Charges		
	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Flood Control	1,323		1,323	36		36
Water Quality	2,111		2,111	2		2
Water Supply		8,556	8,556	0	40	40
Recreation	22,548	14,064	36,612	13	746	759
Regional Income Expansion	9,963		9,963	26		26
Total	35,945	22,620	58,565	77	786	863

Water Supply

In accordance with the Water Supply Act of 1958, as amended, non-Federal interests have been apportioned all construction costs allocated to water supply presently estimated at $8,556,000. Local interests must also assume the annual operation maintenance and major replacement costs allocated to water supply estimated to be $40,000.

Water Quality Control

The cost allocated to water quality control has been apportioned to the Federal Government in accordance with Sec. 3, P.L. 84-660, as amended.

The Federal Water Pollution Control Administration Report concludes that the benefits of water quality control are widespread.

Recreation

Federal Water Project Recreation Act of 1965 requires that non-Federal interests agree to administer project land and water areas for recreation and fish and wildlife enhancement and bear not less than one-half the separable cost for these purposes, and all the separable costs for operations, maintenance, and replacement. One-half of the allocated separable construction cost is estimated to be $13,150,000 and $914,000 for general recreation and fish and wildlife enhancement, respectively. Operation maintenance and replacement costs were estimated at $697,000 and $50,000 annually, for general recreation and fish and wildlife enhancement, respectively. The remaining joint-use construction, operation, and maintenance expenditures allocated to recreation are apportioned to the Federal Government. It will be noted (footnote 3 to table 5-29) that the discounted investment and construction costs allocated to recreation are less than half the total discounted construction and investment costs of the project, and that this is assumed to meet the limitation in Section 9 of the cited Act that costs allocated to recreation shall not exceed those allocated to other purposes.

Regional Income Expansion

All costs allocated to regional income expansion have been apportioned to the Federal Government.

24. STATE AND LOCAL ASSURANCES

The requirements for local cooperation for the construction of Clinchfield Reservoir are that State or local interests pay one-half of the separable construction costs allocated to recreation and all the separable costs for operation, maintenance, and major replacement for that function, and for the State or local interests to agree to reimburse the Federal government for the construction and operation and maintenance costs allocated to water supply. Copies of letters from the State of North Carolina indicating the State's intent to cooperate fully in developing the water supply and recreation functions of the Clinchfield Reservoir are included as Exhibits 5-16, 5-17, and 5-18. Copies of letters from the State of South Carolina, indicating its intent to cooperate in the development of the water supply function of the Clinchfield, are included as Exhibits 5-19 and 5-20.

STATE OF NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

GEORGE E. PICKETT, DIRECTOR
TELEPHONE 829-3003
E. C. HUBBARD ASST. DIRECTOR
TELEPHONE 829-3006
P. O. BOX 9392
RALEIGH, N. C. 27603

March 28, 1969

Colonel Burke W. Lee, Jr.
District Engineer
U. S. Army Engineer District, Charleston
Corps of Engineers
Post Office Box 919
Charleston, South Carolina 29402

Dear Colonel Lee:

Late in 1967 you requested a statement of North Carolina's requirements for water supply storage in the proposed Clinchfield Dam project on the Broad River in Rutherford and Polk Counties. We gave you an estimate. Now that the Appalachia Regions Studies, which include consideration of the Clinchfield Dam, is nearing completion, I wish to review this exchange and make the State's requirements more firm.

I have been advised by members of your staff that it is feasible to include in the Clinchfield Dam reservoir about 716,000 acre-feet of storage for water supply for municipal and industrial use, which would yield an estimated 443,000,000 gallons of water per day. Since our previous correspondence with you on this subject, the Governors of North Carolina and South Carolina have concluded an agreement which provides that water supply storage in such projects as the Clinchfield Dam near the North Carolina-South Carolina State boundary line shall be available on an equitable basis to both States. Our previous estimate of needs for water supply in the area, based on foreseeable requirements and possible industrial development, could come to 300-350 millions gallons per day by the year 2020. Your present planning makes it appear that about 222,000,000 gallons per day would be available to North Carolina from the Clinchfield Dam reservoir, which falls within the expected requirements.

The State of North Carolina desires that water supply storage in the amount of 716,000 acre-feet be included in the Clinchfield Dam project, in order to secure this resource for use by local governments when it is needed. The State intends to give assurances or repayment for the cost of construction, operation, and maintenance of one half of the storage when it is required. It further intends to

transfer to assign this obligation, upon their request, to counties or municipalities, and that they shall execute suitable contractual arrangements when needed; and to stipulate that counties or municipalities shall repay to the State of North Carolina, as and when their requirements are known, those portions of the cost which are expended on their behalf.

Sincerely,

George E. Pickett

George E. Pickett

STATE OF NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

GEORGE E. PICKETT, DIRECTOR
E. C. HUBBARD, ASST. DIRECTOR
P. O. BOX 9392
RALEIGH, N. C. 27603
TELEPHONE 829-3003

March 7, 1968

Colonel Robert E. Rich
District Engineer
U. S. Army Engineer District, Charleston
Corps of Engineers
P. O. Box 919
Charleston, South Carolina 29402

Dear Colonel Rich:

This is in response to your letter of February 5th, in which you ask that the State of North Carolina indicate its intent with respect to recreational development at projects in Appalachia Sub-region D by your study entitled "Development of Water Resources in Appalachia", which is nearing completion. Projects considered are the Clinchfield Reservoir on the Broad River, and reservoirs on the Reddies, Roaring, Mitchell, and Fisher Rivers in the Upper Yadkin River Basin.

Although these projects are still too far in the future for specific recreation plans to have been developed by the State, it is clear that the size, location, and eventual uniqueness of the Clinchfield site will provide an excellent opportunity for recreational advancement in its area. The other four areas being studied are not of sufficient size to be consistent with our State Park development policies, but are susceptible of development, perhaps by local interests, along the lines suggested in the extracts from your report.

It is the State's general intent, under its statutory policy of fullest beneficial use of its water resources, to fully develop and utilize the recreational facilities made possible by the projects, in conjunction with local interests, under the terms of the Federal Water Projects Recreation Act (PL 89-72). Participation by the State will be subject to future appropriations by the General Assembly.

Sincerely,

George E. Pickett

George E. Pickett

cc: Mr. Dan E. Stewart
Mr. E. E. Schwall
Mr. Ralph Andrews
Mr. John R. Hampton

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STATE OF NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

GEORGE E. PICKETT, DIRECTOR
TELEPHONE 829-3003
E. C. HUBBARD ASST. DIRECTOR
TELEPHONE 829-3006
P. O. BOX 9392
RALEIGH, N. C. 27603

WS 69 RJBP

May 26, 1969

Colonel Burke W. Lee, Jr.
District Engineer
U. S. Army Engineer District, Charleston
P. O. Box 919
Charleston, South Carolina 29402

Dear Colonel Lee:

This is in reply to your letter of April 23, 1969, concerning the Clinchfield and Roaring River Dam projects, on which the State gave assurances of local cooperation last July 18th. You state that the allocation of project costs to recreation, and the apportionment of costs for recreation to the State, have increased substantially, and ask for renewed assurances of local cooperation for recreation by the State. This letter revokes and supercedes our letter of July 18, 1968, which gave assurances on these and other projects.

In accordance with the provisions of the Federal Water Project Recreation Act, PL 98-72, the State of North Carolina hereby gives assurance of fulfillment of the following with respect to the Clinchfield and Roaring River Dam projects:

a. It will administer project lands, facilities, and water areas for recreation, and assure access to such development to all on equal terms;

b. It will contribute in kind no less than one-half of the separable first costs allocated to recreation, presently estimated at $2,386,000 for initial construction, and $12,190,000 for future construction as and when needed by reason of the development of an effective demand for it for a total of $14,576,000;

c. It will bear all separable costs of operation, maintenance, and replacements of fish and wildlife and recreation use lands and facilities, presently estimated at $786,000 annually.

The State agency having administrative jurisdiction over fish and wildlife does not feel that the proposed projects provide enhancement of the fishery, and does not ask for enhancement under the provisions of Section 2 (a) (3) of PL 89-72. However, it is the desire of the State that all recreational and fish and wildlife values be developed to their maximum potential. It is our intention that these

values will be developed to the fullest extent justified by demand by State or local interests, and we have in existence programs which will do so. Note that it is contemplated that the local cooperation will be furnished "in kind", as permitted by Section 2 (b) (1) of PL 89-72, and by the assumption of responsibility for administration, operation, maintenance, and replacements.

While we are giving these assurance fully, because they are limited by the development of demand, we do not agree with the basis for the increased value. It is based on an increase in the value of a recreation-day to $5.00 and an estimate of 6,200,000 annual visitor days as the ultimate projected by the Bureau of Outdoor Recreation, at some time in the future. When calculating the value of damages to fish and wildlife values, in order to figure mitigation requirements, we have always been required to use $1.00 as the value of a visitor-day (as prescribed in Supplement No. 1 to Senate Document 97), and a number of visitor-days based on present-day usage. The effect is that the figures are kept low when the State would benefit, and inflated when the State is asked to give assurances of local cooperation. We ask that this inconsistency be reconciled.

Sincerely,

George E. Pickett

George E. Pickett

cc: Mr. E. E. Schwall
Mr. Ralph J. Andrews
Mr. Roy G. Sowers
Mr. Tom Ellis

Sheet 2 of 2
EXHIBIT 5-18

STATE OF SOUTH CAROLINA WATER RESOURCES COMMITTEE
CLAIR P. GUESS, JR., EXECUTIVE DIRECTOR
1411 BARNWELL STREET, COLUMBIA, S. C. 29201
TELEPHONE (803) 758-2514

May 7, 1969

Colonel Burke W. Lee
Department of the Army
Charleston District
Corps of Engineers
P. O. Box 919
Charleston, South Carolina 29402

Dear Burke:

I regret the delay in responding to your letter dated 20 February 1969 relative to South Carolina's position in connection with the water supply storage to be provided in the proposed Clinchfield Reservoir. This matter is of such importance that we delayed our response until the position of the Water Resources Commission could be clearly defined in this connection. This letter, therefore, represents the action of the Commission approved at a meeting on April 25, 1969.

The State of South Carolina takes note that the proposed Clinchfield Dam will contain about 716,000 acre-feet of storage for the purpose of water supply, and that this will supply about 443 million gallons of water a day for municipal, industrial, agricultural, commercial, and residential water use.

The State of South Carolina acknowledges that repayment must be made for the amount of the costs for the storage of this water supply if and when funds are available. It expects, however, that this cost will be shared between the States of South Carolina and North Carolina, with each state repaying that fraction of the cost mutually agreed upon by the two States as a result of future negotiations.

The State of South Carolina will attempt, in future negotiations with the State of North Carolina, to obtain that portion needed by it of the total quantity of water supply available in Clinchfield Reservoir.

The State of South Carolina wishes to secure this available water resource for use by local governments when it is needed and it is the intention of the State to insure that repayment obligations are undertaken by local governments that actually acquire the use of the water supplies.

It is the unanimous desire of the members of the South Carolina Water Resources Commission that the State of South Carolina fully participate to the extent of available resources, in the development of the Clinchfield project and all of its potentials as an economic boost to the development of South Carolina and North Carolina.

With all good wishes,

Sincerely yours,

Clair P. Guess, Jr.
Executive Director

CPGJr:vh

Colonel Burke W. Lee
Charleston, S. C.
May 7, 1969

cc: The Honorable Robert E. McNair
Colonel George E. Pickett
Dr. Robert C. Edwards
Mr. Harry S. Bell

STATE OF SOUTH CAROLINA WATER RESOURCES COMMISSION

CLAIR P. GUESS, JR., EXECUTIVE DIRECTOR

2414 BULL STREET, COLUMBIA, S. C. 29201

TELEPHONE (803) 758-2514

September 9, 1969

Colonel Burke W. Lee
District Engineer
Charleston District
Corps of Engineers
P. O. Box 919
Charleston, S. C. 29407

Dear Colonel Lee:

This is a follow-up to our letter to you dated May 7, 1969, relative to South Carolina's position in connection with the water supply storage to be provided in the proposed Clinchfield Reservoir.

The State of South Carolina takes note that 716,000 acre-feet of storage for public water supply is planned for the Clinchfield Reservoir. We understand that this will make available to the States of North Carolina and South Carolina 443 million gallons per day for municipal, industrial, agricultural, commercial, and residential water use. We see this as not only a badly needed source of water for certain areas in the Appalachian portion of South Carolina, but also as a potential source of supply for use in the fringe areas of Appalachia which are within favorable economic reach of this supply.

South Carolina, therefore, wishes to share with the State of North Carolina on a 50-50 basis the amount of water that will be available for public supply in the Clinchfield Reservoir. This will amount to approximately 220 million gallons of water per day, and South Carolina acknowledges that repayment must be made for the amount of the allocated costs for the storage of this amount of water when funds are available.

The State wishes to secure this available water resource for use by local governments when it is needed, and it is the intention of the State to insure that repayment obligations are undertaken for local governments that actually acquire use of water supplies.

It is still the unanimous desire of the Members of the South Carolina Water Resources Commission that the State of South Carolina fully participate to the extent of available resources in the development of the Clinchfield project.

September 9, 1969

With all good wishes,

Sincerely yours,

Clair P. Guess, Jr.
Executive Director

CPGJr:fs

cc: Mr. L. G. Antle, Regional Economist
Department of the Army
Office of Appalachian Studies
Corps of Engineers
P. O. Box 1159
Cincinnati, Ohio 45201

25. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture, Commerce, Interior, and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Charleston District, Corps of Engineers, or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

Many Federal agencies such as the U. S. Geological Survey, Environmental Science Services Administration, and the Office of Business Economics provided basic data for the project planning, such as climatologic, streamflow, economic records - through regular publications or special reports. Other Federal agencies participated indirectly by assisting the State and local agencies in planning groups.

Several agencies made special studies as an aid in formulation of evaluation of the plan of development for the Clinchfield Reservoir. Reports of these agencies are included in the appropriate indices to this report. The following paragraphs discuss contributions or views by participating agencies.

Bureau of Outdoor Recreation

The BOR surveyed the recreation market area to determine the present and future demand for water-related recreation at the Clinchfield Reservoir. It is estimated that, at ultimate development, 5,700,000 recreation days annually could be expected. The BOR also pointed out, as did the National Park Service, that the project area will contain the site of Fort McFadden (ca. 1768), and several historic structures of local to regional importance that might be subject to inundation. These structures include: (1) Cleghorn Plantation House near the confluence of Cleghorn Creek and the Broad River; (2) Cleghorn Mill; (3) the McKinney House on McKinney Creek; and (4) Coxe Plantation House on Green River. The Park Service suggested that a project cost item of about $25,000 be added for salvage of those items later found worthy of preservation. This has been followed in the project cost estimates.

Fish and Wildlife Service

The Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service evaluated the fish and wildlife conservation and enhancement aspects of the Clinchfield Reservoir. Its report is included in Appendix G to this report.

As recommended by the Fish and Wildlife Service, the following

provisions have been incorporated into the plan of development; fisherman access will be provided to the reservoir. The Service's recommendation for acquisition of about 4,000 acres of land located outside the project area adjacent to the general purchase unit boundaries of the Green River Wildlife Management area will be implemented as a part of the Reservoir Development Plan, to mitigate hunting losses occasioned by construction of the reservoir. Minimum releases necessary to avoid damage to downstream fish habitat during period of low flow will be provided for in the reservoir operations. To meet the recommendation that standing timber be left in certain embayments, reservoir clearing will be coordinated in subsequent planning stages with the Fish and Wildlife Service, the North Carolina Wildlife Resources Commission, and the North Carolina Department of Health. Consideration will be given, in any construction schedule, to having initial impoundment take place in late fall or early winter. The reservoir operation schedule will be coordinated with the North Carolina Wildlife Resources Commission to minimize any adverse effects of project operation on fish and wildlife, while meeting the other purposes to be provided by the reservoir. Maintenance of the maximum conservation pool during the recreation season, consistent with requirements for withdrawals for water supply, water quality control purposes, and flood control purposes will be made to protect recreational values.

Federal Water Pollution Control Administration

The FWPCA supplied evaluations of the need for and value of water quality control storage in the Clinchfield Reservoir. These have been discussed previously in the narrative on water quality needs of the Clinchfield environs, and the extent to which the needs can be met by Clinchfield Reservoir. The FWPCA report may be found in Appendix D to this report.

Southeastern Power Administration

During the evaluation of the Clinchfield Project, the Southeastern Power Administration indicated that it might be advantageous to use the water supply storage which might not be needed during the early years of the project's life for the generation of power. The merits of this idea may appropriately be considered during the advanced engineering and design phase.

National Park Service - The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.
(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

In addition to the above, Public Law 89-665, the National Historic Preservation Act of 1966, requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

26. STATE AGENCIES

Coordination has been maintained throughout the course of these studies with the North Carolina Department of Water and Air Resources, the South Carolina Department of Recreation and Tourism, and the other State counterparts of Federal agencies involved, in conservation, fish and wildlife, recreation, etc.

27. PUBLIC HEARINGS

A public hearing concerning the Clinchfield Dam was held at Chase High School, Forest City, North Carolina, on 3 January 1968. The dam project was presented as a water resource development needed for the economic stimulation of an area comprised of several nearby counties in the States of South Carolina and North Carolina. Approximately 560 persons attended the hearing including Federal, State, County, and Municipal officials, as well as other interested individuals. A preponderance of the statements received at the hearing indicated support for the plan of development, although some representatives of Electric cooperatives indicated disappointment with the decision not to recommend hydropower development as a project purpose. Critical statements questioned the need for the water supply provided in the reservoir, and the merits of taking land for recreational development, along with the merits of the criteria used by the Corps of Engineers in evaluating the economic feasibility of hydropower development. Generally, there is a strong body of support, locally based, for the project.

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SECTION IX - CONCLUSIONS

28. DISCUSSION

Formulation of the plan for development of the water resources of the Broad River Basin by construction of a multipurpose dam and reservoir project at the Clinchfield site, as presented herein, involved determination of the needs for the project and the most feasible solution of these identified needs. It was found that there are, or will be, needs for water control for the purposes of flood control, water supply, water quality, recreation, and economic expansion. The analyses involved in the project formulation clearly indicated that the proposed Clinchfield Reservoir project would provide an effective solution to many needs.

The Clinchfield Reservoir project would consist of the dam and its appurtenant structures; the reservoir and its contiguous areas for access and recreation development; and a 4,000-acre tract adjacent to the Green River Wildlife Management Area, located about 21 miles west-northwest of the damsite. A regional water distribution facility adequate to serve needs along the Spartanburg-Easley-Greenville growth corridor from the Clinchfield project is recommended for subsequent study in Part II, Chapter 8 of this report. This is the only water resource development project proposed for the main stem of the Broad River in this report. The water control capability of this project would be enhanced by the upstream watershed projects of the U. S. Department of Agriculture on tributaries of the Broad River, such as those enumerated in Chapter 8 of Part II of this report, and shown on figure 8-7, ibid. The area benefitted by the project would extend beyond the boundaries of the Appalachian Region.

29. CONCLUSION

The water services provided by the Clinchfield Reservoir project are needed to sustain and enhance the economic growth of this area of Water Sub-region D and adjacent areas.

To bring this plan of development to fruition the cooperative efforts of the U. S. Army Corps of Engineers and the States of North and South Carolina will be required. Supportive plans and actions by other Federal and non-Federal agencies will also be needed. Vigorous support by local development groups and by private enterprise is especially needed to assure realization of the developmental potential. There is every indication at this time that the requirements of local cooperation will be fulfilled and the viable organizational base for industrial and urban development will continue.

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 6

ROARING RIVER RESERVOIR PROJECT

YADKIN RIVER BASIN

NORTH CAROLINA

Office of Appalachian Studies

Corps of Engineers

September 1969

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PART III
PROJECT ANALYSES

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

LIST OF TABLES (Cont'd)

CHAPTER 6 - ROARING RIVER RESERVOIR

TABLE OF CONTENTS

LIST OF EXHIBITS

PART III
PROJECT ANALYSES

CHAPTER 6 - ROARING RIVER RESERVOIR

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Roaring River multiple-purpose reservoir site is located in the Piedmont physiographic province, in Wilkes County, North Carolina, about 50 air miles west of Winston-Salem. The project with a 159-foot high dam located 2.9 miles above the confluence of the Yadkin and Roaring Rivers would control 129 square miles of drainage area in the headwaters of the Yadkin River.

Major physical features of the project would be the 970-foot long earth fill dam; a 200-foot wide spillway, saddle type with a concrete ogee crest uncontrolled; recreation areas with appropriate public-use facilities at various points around the reservoir having a total storage capacity of about 77 thousand acre-feet (11.2 inches of runoff from the contributing drainage area), and surface area of 820 acres.

2. PROJECT IMPACTS

The reservoir project has been formulated to provide water services which will both meet needs and relieve water-related developmental impediments for an area extending downstream past Winston-Salem, North Carolina. The specific benefits realized from the project would be:

a. Flood damage reduction and changed land use capability

b. Water supply for municipal, industrial, and rural uses

c. Water pollution control

d. Fish and wildlife enhancement

e. Outdoor recreation

f. Economic development

The reservoir, in conjunction with operating W. Kerr Scott Reservoir and authorized Reddies River Reservoir, could offer a substantial reduction in flooding hazard downstream to Elkin and Jonesville and, to a lesser extent, farther downstream to High Rock Lake. About one-fourth of the reservoir storage would be used to store excess inflows which would be released to augment streamflow for

the purpose of water quality improvement along the Yadkin River to below Winston-Salem. About 7 percent of the reservoir storage would be used for water supply purposes. Additional releases from this storage would enable communities along the Yadkin River, including Winston-Salem, to withdraw additional water for municipal, industrial and rural water uses during periods of deficient streamflow. Enhanced opportunities for fishing would occur because of the increased water surface, improved environment for fish life and improved access to the 821-acre conservation pool. Reservoir releases made for water supply and water quality control will improve the fishing opportunities in the tailwater area of the dam and along the stream. A portion of project lands would be managed to improve wildlife habitat and thus improve hunting opportunities. Opportunities for about 210,000 annual recreation days will be afforded to the people seeking outdoor recreation activities from the reservoir pool and contiguous access areas. Economic development in this portion of Appalachia will be enhanced by the employment opportunities associated with project construction and operation, from the expenditures for recreational uses of the project, by the increased employment permitted by the additional water supply afforded to the Upper Yadkin Basin and from the employment provided by firms which could efficiently locate on otherwise flood-prone lands along the Yadkin River. Water quality control measures will help maintain the environmental quality of the area as economic development increases.

3. COSTS AND BENEFITS

Costs of constructing the Roaring River Reservoir are estimated at $10,758,000 and annual charges are estimated to be $469,000. The economic development which can be related to the reservoir project, as outlined above, will cost on the order of $93.4 million with average annual equivalent charges of $1,168,000. Annual benefits for the development are estimated as follows:

	Income	
	National	**Regional**
Users of the water project services	$ 581,000	$ 508,000
Expansion effects		
Redevelopment	39,000	117,000
Development	6,639,000	7,629,000
Total Expansion	6,678,000	7,846,000

Using the preceding, the ratio of user plus redevelopment benefits to water project costs, indicates a minimum index of performance in relation to increasing national income and results in an index of performance of 1.3. The ratio of total regional benefits to total costs indicates an index of performance in regards to increasing regional income of 5.4.

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accordance with present Federal policy, costs of the Roaring River Reservoir have been apportioned between Federal and non-Federal interests. The Corps of Engineers would construct and operate the project. Operation of the reservoir project would be shared with non-Federal interests who would operate the general outdoor recreation and fish and wildlife lands and facilities, and coordinated with those interests which acquire rights to storage space for water supply.

Construction costs allocated to water supply would be apportioned to non-Federal interests who would reimburse the Federal Government under provisions of the Water Supply Act of 1958, as amended, (PL 85-500). Construction costs and operation and maintenance costs allocated to flood control would be apportioned to the Federal Government under applicable flood control legislation since flood control benefits are widespread, extending about 133 river miles downstream. Construction, operation and maintenance cost allocated to water quality control is apportioned to the Federal Government under provisions of the Water Quality Act of 1961, as amended, (PL 87-88). The FWPCA has determined the need for and benefits of water quality control; such benefits are widespread, extending along about 110 river miles. One-half of the separable costs of recreation (including fish and wildlife enhancement measures) are apportioned to non-Federal interests, who must agree to operate and maintain the facilities and lands under provisions of the Federal Water Projects Act, as amended, (PL 89-72). Therefore, the remaining separable costs and all joint costs allocated to recreation are apportioned to the Federal Government. A portion of the joint costs of the project were allocated to regional income expansion and are apportioned to the Federal Government. A summary of apportioned costs is presented in the following tabulation:

Purpose	Apportioned Construction Costs ($1,000) Federal Government	Non-Federal Interests
Flood Control	3,459	--
Water Supply	--	943
Water Quality	1,429	--
Recreation	896	458
Regional Income Expansion	3,573	--
Total	9,357	1,401

The State of North Carolina has indicated support of the reservoir project as formulated and willingness to undertake the responsibility for providing the assurances required of non-Federal interests. Prior to construction, non-Federal interests should furnish assurances to repay their share of the apportioned costs; establish downstream encroachment lines to permit efficient reservoir regulation; contribute to the pollution control by providing adequate treatment or other

waste control methods; hold and save the United States free from water rights and other damage claims arising from construction and operation of the project; and to the full extent of their legal capability, exercise control against diversion of streamflow available for water quality control, and prevent improper withdrawal of water supply streamflow, when releases of such flows use the natural stream channels for conveyance.

SECTION II - PROJECT FORMULATION

5. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

Needs for water resource development in the context of alleviating current problems and for the removal of developmental constraints for the Upper Yadkin River Basin have been discussed in Chapter 7 of Part II.*/ In summary, flood control needs are more pressing in the upper reaches of the basin with damage centered and the potential pressure on flood plain development greatest at Wilkesboro, North Wilkesboro, Elkin and Jonesville, North Carolina while the water supply and water quality needs appear to be most noticeable at and near Winston-Salem. The substantial needs for water related outdoor recreation opportunities and power production have less geographic specificity.

Damages from overbank flooding are shown in table 6-1. An estimate of the needs for future urban land development in the flood plain is also included. This estimate is aimed at describing one potential bottleneck to efficient economic development of the region.

Even more significant, from the standpoint of economic development, is the need for land to be used for future urban development in the Upper Yadkin Basin. The topography limits the availability of upland sites with favorable slopes; transportation and communications arteries are located near or in the flood plain. Thus, the pressure for flood plain development will continue. This investigation is concentrated on estimating the amount of flood plain lands which should be developed for urban uses and later comparing the effectiveness of alternative projects in meeting the need. The estimated need for additional flood plain development for urban uses is as follows:

Urban Center	Acres
Wilkesboro-North Wilkesboro	300
Elkin-Jonesville	230
Winston-Salem	580

*/ Needs at Mt. Airy are ignored here since Roaring River Reservoir would not significantly affect project scale or scope in meeting needs at Mt. Airy.

TABLE 6-1

AVERAGE ANNUAL FLOOD DAMAGES
YADKIN RIVER

(In $1,000 - 1967 Values and Development)

Damage Zone	From	To	Urban Damages	Other Damages a/	Total Damages b/
5	W. Kerr Scott Dam	Roaring River	5.6	4.9	10.5
4	Roaring River	Mitchell River	37.5	16.8	54.3
3	Mitchell River	Fisher River		24.9	24.9
2	Fisher River	Upper Donnaha Damsite		63.6	63.6
1	Upper Donnaha Damsite	High Rock Lake		310.5	310.5

a/ Includes agricultural and non-agricultural damages.

b/ 1967 damages remaining with W. Kerr Scott Reservoir (existing) and Reddies River Reservoir (authorized) in operation. The latter reservoir expected to be in place by 1980.

The need for water supply, in the sense of permitting accelerated economic development to proceed, is less critical in earlier time periods than the need for flood control. However, additional sources will be required to maintain the pace of development foreseen in the area. A summary of water supply needs in the Upper Yadkin River follows:

Growth Center	2020 Needs (MGD)	Available[a] Supply in 1980	Net Needs (MGD)	Decade of Shortage
Wilkesboro-North Wilkesboro	33	33	-	
Elkin-Jonesville	48	48	-	
Winston-Salem	297	262	35	2000-2010

a/ Assuming Reddies River Reservoir operational

The Federal Water Pollution Control Administration (FWPCA) found a need for 35,000 acre-feet of storage in the Upper Yadkin Basin for streamflow regulation for water quality purposes in addition to adequate treatment of municipal and industrial wastes at their source. The critical point of deficient flow is in the Upper Yadkin River downstream from Muddy Creek, a tributary which receives treated wastes from Winston-Salem. A portion of this need (about 12,000 acre-feet) can be met by the Reddies River Reservoir.*/

Needs for increased opportunities for water related outdoor recreation opportunities have been evaluated by BOR. The unmet needs approximate 19 million recreation days (in 2020) for the Upper Yadkin Basin. More water surface is needed at present. Management and control of project lands, reservoir and the downstream flows can enhance the opportunities for hunting and fishing.

6. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

The range of alternatives for meeting the set of water needs varies from mutually exclusive alternatives of structural versus non-structural measures to a system of complementary measures which includes structural and non-structural components. A legitimate recommendation should place relevant alternatives in a system which would seek to maximize the net benefits and which would provide positive net benefits to the nation and to the region.

*/ Exact allocation of storage for water quality control between Reddies and Roaring River Reservoirs will be studied in advanced engineering and design.

The following alternatives were considered, individually and collectively as appropriate:

a. Structural

(1) Local flood protection works
(2) Flood proofing
(3) Evacuation of the flood plain
(4) Reservoirs on tributaries and main stems
(5) Lagooning the wastes and discharge in periods of high streamflow
(6) Advanced waste treatment
(7) Single purpose outdoor recreation development
(8) Ground water development
(9) Water saving process systems and devices

b. Non-Structural

(1) Flood plain information and zoning
(2) Flood warning systems

The possibility of local flood protection works including levees and floodwalls and channel improvement appear limited in the Upper Yadkin River because of the dispersed developmental pattern along the river. Protection of urban areas only would leave rural developments unprotected. The area protected by levees and floodwalls would have to extend sufficiently to provide room for urban growth. In the relatively intensively developed areas, levees and floodwalls use up land which could be developed, resulting in more extensive land use over a greater area. Given operation of W. Kerr Scott and Reddies River Reservoirs, the additional protection afforded by Roaring River Reservoir would give a high degree of protection to Elkin and Jonesville and the intervening reach, while greatly reducing damages to rural development and transportation routes downstream to High Rock Lake.

Flood proofing does not appear to be an economically feasible measure to protect agricultural development or for many utilities such as railroads and highways or to many structures already located in the flood plain. Flood plain zoning has similar liabilities and should be used only in conjunction with land use studies which would define the level of income foregone from regulation of flood plain development. However, both alternatives can be used as tools of flood plain management to inhibit the uneconomic development of flood plains. Total evacuation of the flood plain would entail significantly higher costs than any practical flood control plan, yet evacuation of certain areas might be a feasible alternative. In much of the Upper Yadkin Basin, flood plain development is required to allow economic development to continue and as such the best alternatives appear to be those which would allow the development to proceed in an orderly and economic manner.

The effectiveness of a system of small upstream detention structures was not explicitly analyzed for comparison against the Roaring River Project since an equivalent level of protection would require an extensive number of such structures, whose costs could run to about twice that of the larger reservoir project. While the system of small upstream detention structures could provide protection against cropping season floods to a larger area more effectively than the large reservoir, difficulty in controlling reservoir releases would sharply reduce the level of protection to urban areas on the mainstem from larger storms. Thus, the direct comparison of a large reservoir versus small upstream detention structures is not completely valid because each type is designed for different objectives.

The FWPCA investigation of water quality (Appendix D) concludes that the most practical alternative to dilution of wastes, treated to 85% of first stage BOD removal, would be advanced waste treatment. The critical reaches are on the mainstem of the Yadkin downstream from Muddy Creek, thus diversion to a larger stream is not practical or feasible. The cost of advanced waste treatment was estimated to be $975,500 annually, as compared to the costs of a single-purpose reservoir at the Roaring River site which could provide equivalent dilution for a cost of $336,800 annually (adjusted to a somewhat lower level in project benefit analyses to correct this value to a hundred-year amortization period).

Water supply could be furnished from large and small impoundments, ground water development; or the needs could be modified by substitution of water saving processes and devices or from exclusion of those firms which are heavy water users in favor of firms which have very low water requirements. In terms of substitution of technology or exclusion of "wet" industries, the economy of providing additional water supply over the alternatives is considered positive. Projected needs make some allowance for technological changes but the relatively minor influence of water on production costs would indicate that most firms would react most positively to the availability of plentiful supplies of water or to its relative scarcity rather than to its cost. The United States Geological Survey (USGS) Appendix on Groundwater (Appendix H) indicates that groundwater costs would be on the order of 5 cents per thousand gallons delivered to the well head in the Upper Yadkin River Basin. Surface storage costs range a little over one-tenth as much (based on average cost for Roaring and Reddies River Reservoirs). The aspect of transmission cost has been omitted from this comparison, but the advantage of surface storage cost over groundwater appears to be sufficient to preclude the consideration of groundwater for more than small supply sources.

Alternatives for providing water related outdoor recreation opportunities includes small and large impoundments for single and multiple-purpose uses. The use of costs undertaken by state park

systems, in the Ohio River Basin to provide relatively similar quality and quantity of opportunities, is considered a relevant alternative cost parameter. There does not appear to be any significant opportunities for the expansion of recreation facilities at any publicly owned impoundment in the Upper Yadkin River Basin. The magnitude of needs indicates that several large impoundments will be required in addition to all foreseen upstream watershed projects and other impoundments. Future studies of mainstem reservoir sites will be significantly influenced by these needs.

The water project alternatives to the reservoir considered in the report do not appear to satisfy the full range of water needs required to maintain and stimulate the rate of economic development enjoyed at present in the Yadkin River Basin. Meaningful tradeoffs between water resource and other types of public investment such as roads, health and education are not available at this time. Certainly the continuing program of water resource development would not be abruptly changed even if the Appalachian Regional Development Act of 1965 had not been enacted. The instant proposal has been evaluated in the context of the dynamic program of public investment which includes water.

Evaluation of Costs and Benefits

A comparison of net benefits was made between all relevant alternatives. Costs and benefits were compared on two levels: one, at the level of project cost - user benefits, and second, at the impact on employment and incomes which the project could affect. The major impact on employment and income opportunities is felt in the quantification of needs. Needs appear when a constraint to economic development is perceived. Thus, the analysis always keeps a heavy orientation towards the set of needs which represent the level of possible economic development. User benefits and project costs comparisons appear to be relevant only in the limits set by the definition of needs. Thus, if alternative projects which meet the set of needs are compared, they may be ranked by net user benefits.

User benefits were determined by conventional evaluation procedures which basically reflect the value which persons would be "willing to pay" for the water goods and services in a market sense. Employment and income effects are determined by methods which estimate the change in national income and the change in Appalachian Regional Income given the implementation of the water resource plan, completion of other necessary public investments and the favorable response by private industry and trade. Thus, these income gains or expansion effects represent the measurement of the initial effects of the water services (user benefits) on the users plus their subsequent investment and consumption decisions. If persons who could otherwise be unemployed are gainfully employed, whether in construction and operation of the water projects or by firms which subsequently use the water services or are affected by other firms which

use the water services, a real gain in national and regional income is attained. If new job opportunities become available to otherwise employed persons at a gain in income, the gain would be net to the nation and to the region. If investment and production decisions made by one firm (locating and expanding because of water services) reduce the cost structure of another firm via external economies, subsequent gains of employment and income represent net gain in national and regional income. If persons who are otherwise employed are transferred from outside the region to inside the region, as a result of an investment decision such as mentioned above, the region would gain but there would be no net gain to the nation.

User Benefits

Flood control benefits were estimated by construction of a curve, derived from damage survey which related actual damages to a specific flood stage or specific historical flood. Hydrologic studies estimated the frequency for the occurrence of various flood stages. The product of flood frequency and stage damage curves equal the average annual damages for specified levels of development. The damages were adjusted to reflect future flood plain development and represent the best judgment of the rational decisions which would affect future development in the sense of willingness-to-pay concept.

Water supply benefits are related to "willingness to pay" by pricing out the relevant alternatives to provision of the required level of needs for water supply. The values represent the cost of the kind of water supply projects that municipalities and industrial firms would most likely undertake in the absence of this multiple-purpose reservoir project. Pumping from other river sources or construction of single-purpose impoundments are considered to be the most likely alternatives. In the case of Winston-Salem, the most likely alternative would be additional surface impoundment.

Water quality benefits were derived from the investigation undertaken by FWPCA. The most favorable alternative is a single-purpose reservoir on the Roaring River Reservoir site. As previously discussed, the average annual benefit would be $336,800, adjusted to $324,000 to reflect 100-year amortization and an adjustment in contingencies to correspond to project cost estimates. Benefits attributable to Roaring River Reservoir would be $167,000. Recreation, and fish and wildlife enhancement benefits were estimated in accordance with procedures which reflect a judgment of "willingness to pay" and the estimated use in recreation days. Bureau of Outdoor Recreation and the Fish and Wildlife Service have evaluated the project proposal and estimated benefits for general recreation, and fish and wildlife enhancement use of the project.

Expansion Benefits

The expansion effects on national and regional income have been estimated to reflect the new resource combinations, and thence new employment opportunities, which would evolve by construction of the

water project, completion of complementary public investment programs, and favorable investment decisions by private firms. Two classes of expansion benefits are estimated; redevelopment benefits which reflect the direct employment generated by project construction and operation; and developmental benefits which reflect the subsequent investment decisions of the private and public sectors which are influenced by the construction and operation of the water project.

Expansion effects in varying degrees and from various relationships will accrue to the region and to the nation for direct employment utilized in construction and operation of water projects; from the reduction of overbank flooding which will enable orderly development of lands in the Elkin-Jonesville area for urban uses: for water supply and water quality releases which will permit additional employment and incomes along the river, including Winston-Salem; and from the employment generated by expenditures by recreation visitors to the project. Some of the income flows represent intra- and interregional transfers, and as such represent no net gain to the nation. Others represent employment opportunities for the otherwise unemployed and upgraded employment opportunities for the underemployed - and as such, represent real gain in national and regional incomes. Transfers from outside Appalachia to the region represent a regional but not a national gain. The economic analysis presented in Chapter 7 of Part II of the report indicated a rather high rate of employment with correspondingly low unemployment rates for the water region. Yet incomes are low, thus a strategy for upgrading employment opportunities would appear to be a most useful device for raising incomes in the region and for national income augmentation. The planning projections make allowance for this strategy; thus, the water projects were formulated against the water needs implied by the developmental strategy.

The costs and benefit flows were converted to a comparable time base by compound interest methods using the 3-1/4 percent interest rate. Amortization schedules for the water project reflect a 100-year economic life, while costs associated with development investment were amortized over shorter periods which reflect their economic life. Evaluation of expansion benefits reflect the second and subsequent rounds of the economic response to a public investment, raising the question of diseconomies which may accompany such a program. The diseconomies can be thought of as opportunity costs of the development program and include, for instance, the changes of income which accompany the lost output of land and improvements which would be purchased for the reservoir. These costs may be greater than the market value of lands, which are accounted for in direct costs. An attempt has been made in this report to evaluate these costs and to reduce expansion benefits by the amount of income foregone through the period of analyses.

Selection of Project

Roaring River Reservoir has been designed to operate as one element in a planned system for the Upper Yadkin River Basin to meet the long range water resource needs of the upper basin. The need for flood control at Elkin-Jonesville, and the need for water related recreation opportunities are urgent and place the Roaring River project in the immediate priority category.

The relative merits for recommending development of the Roaring River project after the Reddies River Reservoir, and before the potential sites on Mitchell River, Fisher River or mainstem sites at Upper Donnaha and Styers Ferry, have been presented in Chapter 8 of Part II of the Appalachian Water Resources Survey entitled, "Shaping the Plan for Subregion D". Implementation of this order of construction would meet the needs of the basin in an orderly and economic manner.

Preliminary screening studies evaluated sites on other tributaries of the Yadkin River above Elkin-Jonesville, but none of the considered sites offered the degree of control which could be expected from the Roaring River project, and none offered any promise of more economical development.

Seven sites were initially considered along Roaring River. Preliminary screening eliminated five upstream sites for various reasons which would influence the unit cost for storage. None of these sites offered any cost advantage and all offered a lower degree of control. Of the two remaining sites, the upstream site (located 7,300 feet upstream from the selected site) controlled less drainage area and appeared to cost more (per unit of storage) than the selected site. The selected site offered a better location of the spillway; the highest degree of control; a favorable foundation condition; a satisfactory alignment of dam and spillway; adequate materials favorably located for rolled-fill construction of the embankment; no significant increase in relocation costs, and would provide favorably-located recreation access points.

7. PROJECT'S CAPABILITY TO MEET NEEDS

Project Scale

The purposes and scale of development of the Roaring River Reservoir site were selected with the project acting as a unit in the system, including operating W. Kerr Scott Reservoir and authorized Reddies River Reservoir, with a view towards meeting the needs of the basin in a systematic and economic manner.

As previously indicated, flooding on the Upper Yadkin River is quite serious and the need for continued flood plain development is pressing if the economy of the area is to progress. The allocation of space to flood control is based on providing the maximum practical degree of control at Elkin-Jonesville. The selected storage (7 inches of runoff from contributing drainage area) would control all floods of

record and approach control of the standard project event. Average annual damages at Elkin-Jonesville will be reduced by 40 percent with construction of Reddies River Reservoir. An additional 27 percent reduction in damages has been attributed to the flood control storage allocated to the Roaring River project. Additional control would not add appreciable reductions at the downstream damage points, because of flows from uncontrolled drainage areas.

The need for water quality control was established by FWPCA. The point of need is below Muddy Creek which enters the Yadkin River downstream from Winston-Salem. Flow requirements were converted into storage requirements and allocated to Reddies, Roaring, and Mitchell River projects in a manner which would balance operation of the system and permit required water supply needs to be met. When the Mitchell River project appeared to be less effective on an overall basis than other projects, a rebalancing of water quality allocations was indicated. Of the total storage requirement of 35,000 acre-feet (in the system), 12,000 acre-feet was allocated to Reddies Reservoir and 18,000 acre-feet to the Roaring River project. The additional 5,000 acre-feet should be reallocated to Reddies and Roaring, but later design studies could expeditiously provide a basis for this decision.

Water supply needs at Winston-Salem can be partially met by Roaring River Reservoir in an economical manner. About 16 mgd, in addition to minimum releases required to meet riparian obligations, could be contributed by the 5,160 acre-feet included for water supply. This storage should, in addition to the water supply included in W. Kerr Scott and Reddies Reservoirs, meet all foreseen needs in the Winston-Salem area till about 2010. The storage draft curve, included as exhibit 6-1, indicates that additional conservation storage would contribute little additional yield (1,000 AF = .7 cfs or .45 mgd; costs $1,500,000/.45 = $3,330,000/mgd).

Recreation has been included on the conservation pool since additional storage would contribute limited additional pool area, and nominal incremental benefits (10,000 AF would add 300 acres of surface area and about $18,000 in benefits for about $22,000 in annual costs).

In summary, increasing the scale of Roaring River Reservoir flood control or recreation would not add enough benefits to cover the additional cost; while decreasing flood control space would risk the loss of the expansion benefits expected at Elkin-Jonesville because of the increased flooding risk which would accompany the lower degree of control. The incremental costs of adding space to Roaring and Reddies Reservoirs is believed to be very similar, so optimization of the two-project system, from the standpoint of water supply and water quality control, could be easily made by equating the slopes of their respective yield curves (yield/ storage). The amount of water supply storage included is consistent with the strategy of the basin plan, and with the desires of the State of North Carolina.

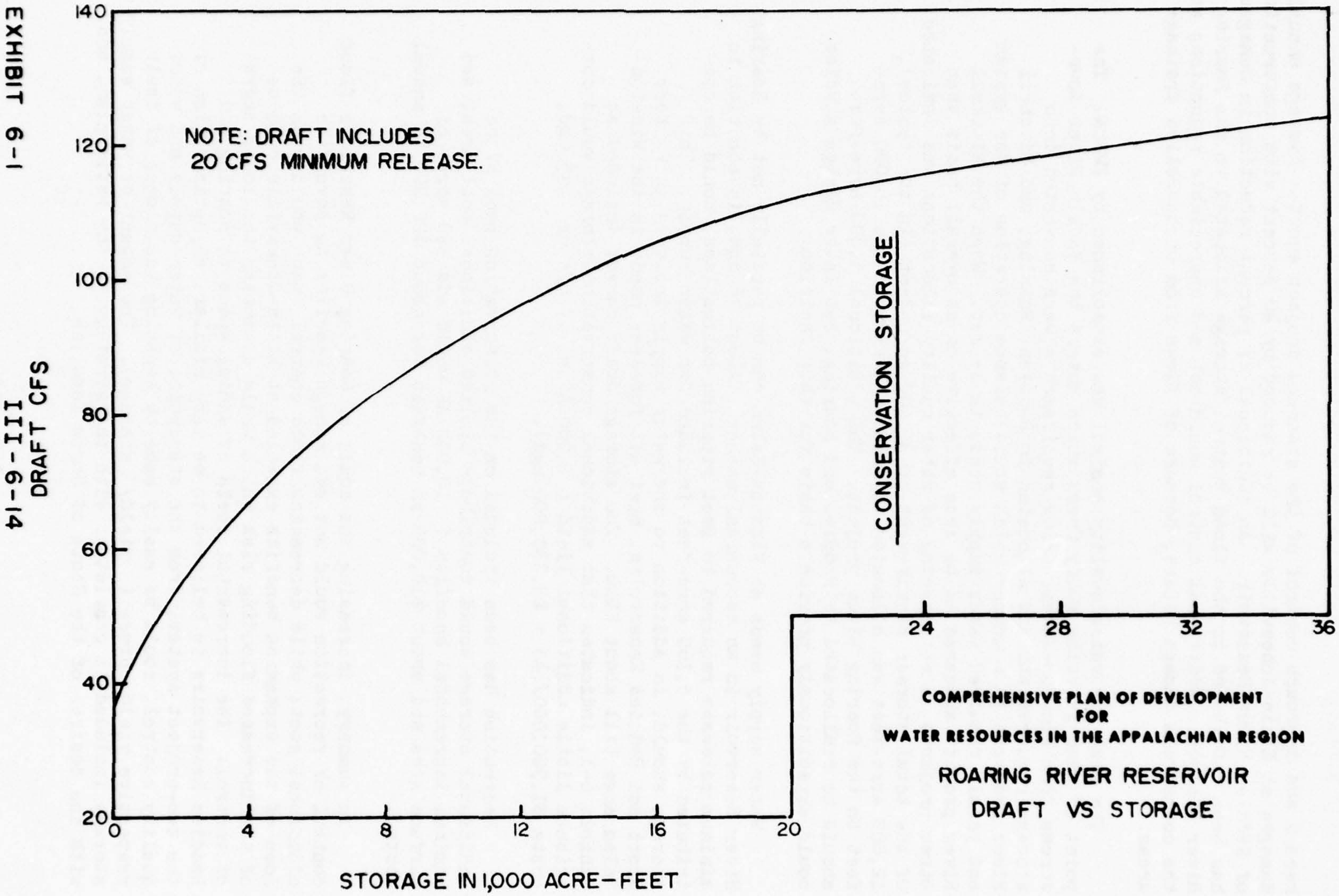
NOTE: DRAFT INCLUDES
20 CFS MINIMUM RELEASE.
DRAFT CFS
140
120
100
80
60
40
20
0
4
8
12
16
20
24
28
32
36
STORAGE IN 1,000 ACRE-FEET
CONSERVATION STORAGE
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
ROARING RIVER RESERVOIR
DRAFT VS STORAGE

EXHIBIT 6-1

Table 6-2 presents a comparison of project costs and user benefits for reservoirs, with various capacities, at the selected project site and, indicates that the selected scale substantially meets the requirement of net benefit maximization. Exhibit 6-2 presents the cost curve of the storage at the adopted site.

TABLE 6-2

ESTIMATES OF COSTS AND BENEFITS FOR ALTERNATE SCALE OF DEVELOPMENT
ROARING RIVER RESERVOIR, N.C.

Reservoir Storage Inches	Reservoir Storage Ac.ft.	Storage Allocation Purposes	Storage Allocation Ac.ft. (1000)	Annual Benefits ($1,000)	Project ($1,000) Const. Costs	Project ($1,000) Annual Charges	Net Benefits ($1,000)
8	55,040	FC	28.1	84			
		WS	3.0	42			
		WQ	18.0	167			
		Rec.		214			
		Red.		35			
		Total		542	9,450	428	114
11.24	77,300	FC	48.2	147			
(Selected)		WS	5.16	50			
		WQ	18.0	167			
		Rec.		217			
		Red.		39			
		Total		620	10,758	469	151
12	82,560	FC	52.9	162			
		WS	5.72	55			
		WQ	18.0	167			
		Rec.		217			
		Red.		42			
		Total		643	11,490	501	142
16	110,080	FC	61.94	190			
		WS	24.2	96			
		WQ	18.0	167			
		Rec.		239			
		Red.		54			
		Total		746	14,900	650	96

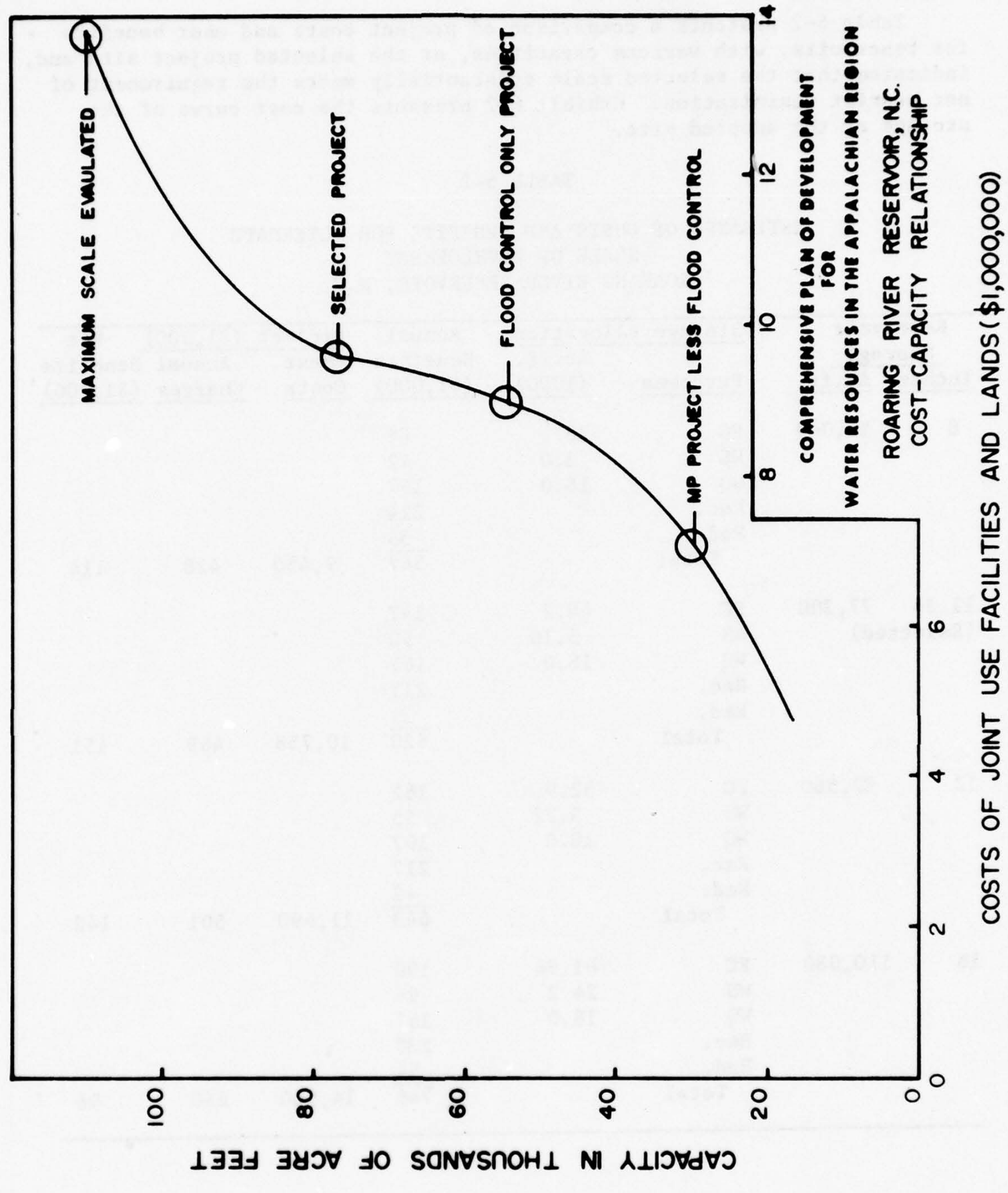
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
ROARING RIVER RESERVOIR, N.C.
COST-CAPACITY RELATIONSHIP
MAXIMUM SCALE EVAULATED
SELECTED PROJECT
FLOOD CONTROL ONLY PROJECT
MP PROJECT LESS FLOOD CONTROL
CAPACITY IN THOUSANDS OF ACRE FEET
COSTS OF JOINT USE FACILITIES AND LANDS ($1,000,000)
0
20
40
60
80
100
2
4
6
8
10
12
14

EXHIBIT 6-2

8. SELECTED PROJECT

The Roaring River Reservoir area is shown on exhibit 6-3. It includes a rolled-earth embankment with a maximum height of 159 feet. A saddle spillway will be located on the left bank. The concrete ogee crest will be uncontrolled at elevation 1092 feet msl. An intake structure with a multiple level intake tower will allow water from various levels to be withdrawn for discharge, and additional gates will control discharge through the outlet works. The reservoir would be 5.2 miles long and have an area of 821 acres at maximum conservation pool. The project would provide for the control of floods; low flow regulation for water quality control; municipal and industrial water supply; sediment retention, and general outdoor recreation. It would also provide for increased fishing opportunities in the reservoir pool, tailwater and downstream areas, and increased hunting on the project lands managed for wildlife enhancement.

The project, in conjunction with W. Kerr Scott Reservoir and Reddies River Reservoir, will reduce flood damages in the upper reaches of the Yadkin River to negligible proportions and, to a lesser degree, downstream to High Rock Lake. In conjunction with Reddies River Reservoir, it will provide low-flow augmentation for water quality control at Winston-Salem past the year 2000. With W. Kerr Scott and Reddies River Reservoirs the needs for water supply along the main stem to High Rock Lake would be met till after the year 2000. The reservoir and project lands will afford a substantial increase in the opportunities for outdoor recreation in the Yadkin River Basin.

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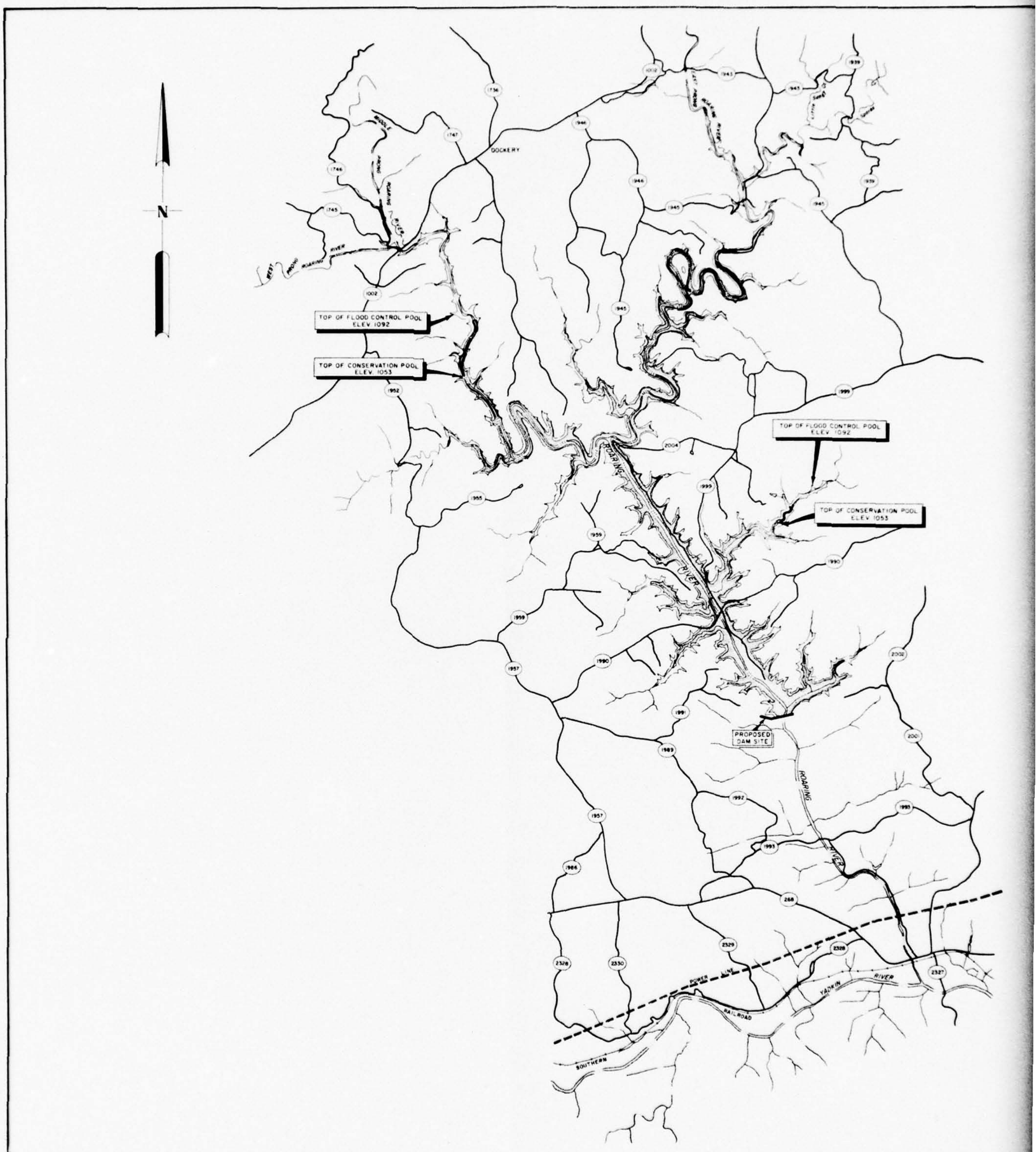
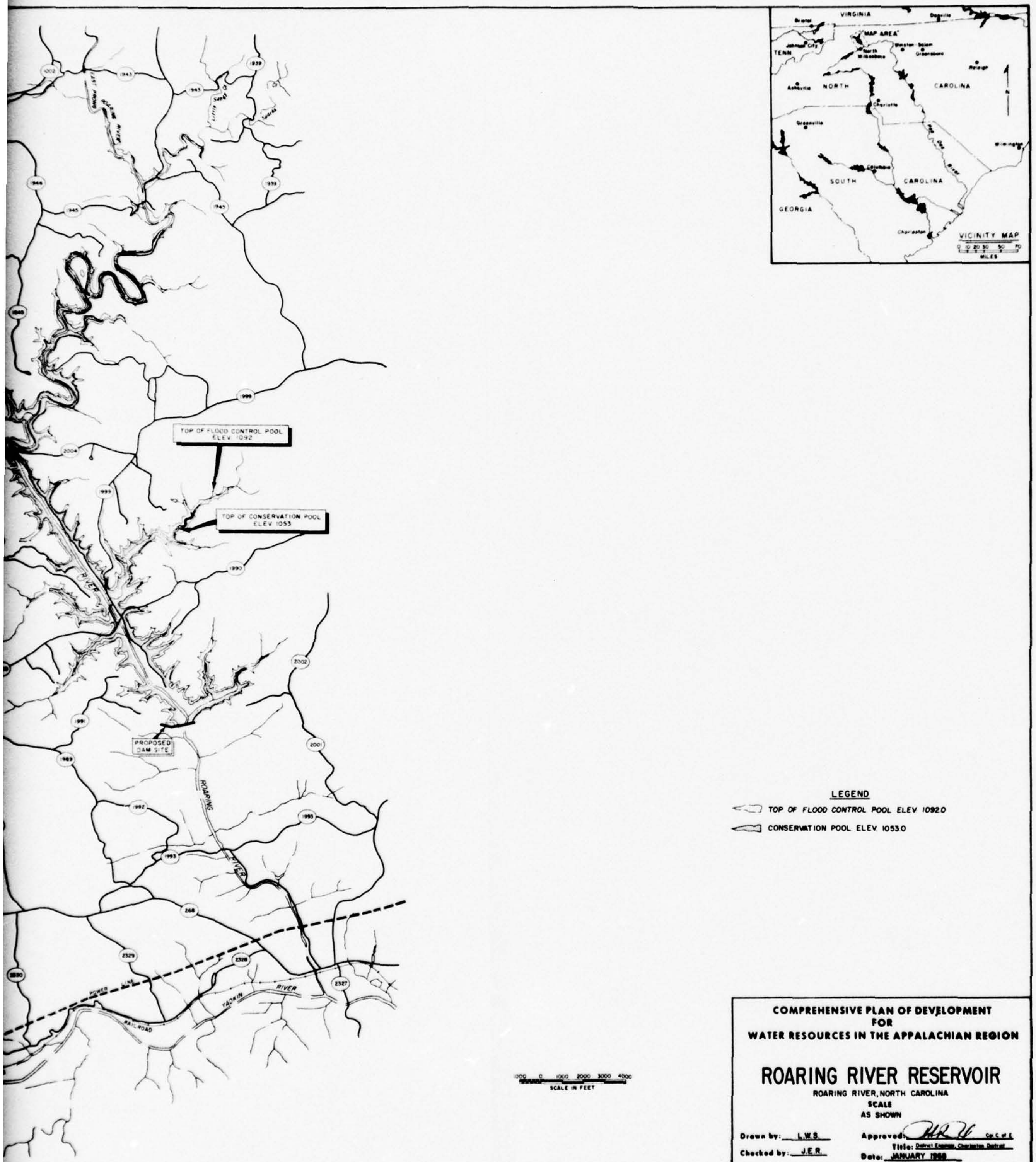


2



VIRGINIA
"MAP AREA"
TENN
NORTH
CAROLINA
SOUTH
CAROLINA
GEORGIA
VICINITY MAP
MILES
TOP OF FLOOD CONTROL POOL ELEV. 1092
TOP OF CONSERVATION POOL ELEV. 1053
PROPOSED DAM SITE
ROARING
RIVER
YADKIN
RIVER
RAILROAD
LEGEND
TOP OF FLOOD CONTROL POOL ELEV 1092.0
CONSERVATION POOL ELEV 1053.0
1000 0 1000 2000 3000 4000
SCALE IN FEET
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
ROARING RIVER RESERVOIR
ROARING RIVER, NORTH CAROLINA
SCALE
AS SHOWN
Drawn by: L.W.S.
Checked by: J.E.R.
Approved:
Date: JANUARY 1968

EXHIBIT 6-3

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SECTION III - DESIGN CONSIDERATIONS

9. INTRODUCTION

Detailed hydrologic, hydraulic, geologic, cost and benefit analyses were made to determine the storage requirements and structural design of the Roaring River Basin project to assure compliance with established design criteria in regard to safety, function and economy.

Relocations, real estate acquisition requirements, and recreation development were estimated in accordance with established criteria and policy.

10. HYDROLOGIC

Hydrologic analyses were made to determine the storage allocation needed in Roaring River Reservoir to accomplish the project purposes and to establish the parameters of hydraulic design of the structure. These analyses include the evaluation of available climatological and hydrologic records, and preparation of hypothetical floods used for structural design. A brief description of hydrologic characteristics of the project area and design data for the dam and reservoir follows.

General Climatology

Climatological and meteorological records were obtained for the stations maintained and operated by the Weather Bureau of the Environmental Science Services Administration and are available in their publications. The climate is largely sub-tropical in nature. Sub-zero temperatures are rare and of very short duration. Maximum summer temperatures are around 90 degrees Fahrenheit. Considerable precipitation, moderate cloudiness and wind movement, and high humidity are general characteristics of the weather. Weather changes are frequent in the winter, and tropical hurricanes enter the area in late summer and early fall from the South Atlantic and Gulf Coasts.

Representative USWB stations with long-term records were selected. Excerpts from their records are included in this Report as described below.

Temperature

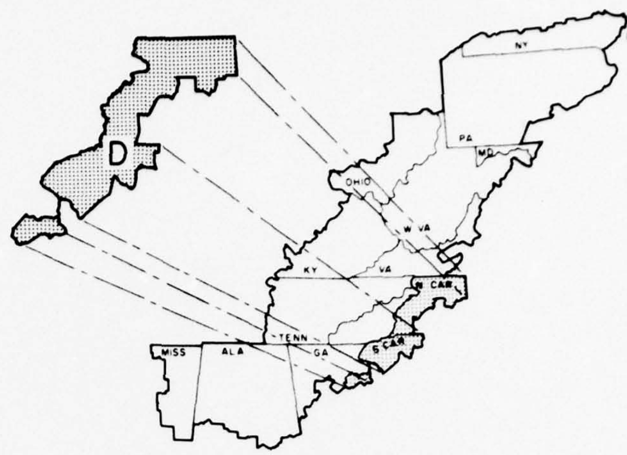
Maximum temperatures usually occur during July or August. Upon occasions, the temperature may exceed 100 degrees but this does not occur every year. Minimum temperatures for the area occur during December, January and February and are usually below freezing. Occasionally, the temperature in the higher elevations will fall below zero degrees Fahrenheit. The average annual and the average January and July temperatures, together with the extremes of record for the selected stations are given in table 6-3. Their locations are shown on exhibit 6-4.

TABLE 6-3

TEMPERATURE DATA FOR SELECTED STATIONS
ROARING RIVER RESERVOIR, NORTH CAROLINA

Station	County	Period of Record	Average Temperature Ann.	Jan.	Jul.	Extremes Max.	Min.
Caroleen	Rutherford	1900-66	60.1	41.7	78.9	106	- 8
Tryon	Polk	1917-66	60.1	43.1	76.9	105	- 3
Lenoir	Caldwell	1872-66	57.2	39.1	75.4	106	-18
Mount Airy	Surry	1889-66	56.8	38.1	75.4	105	- 9
Statesville 2 NNE	Iredell	1901-66	59.2	40.9	77.4	105	- 8


N
VIRGINIA
NORTH CAROLINA
MT AIRY
COPELAND
WILKESBORO
LENOIR
MOCKSVILLE
STATESVILLE
YADKIN COLLEGE
MARION
LAKE NORMAN
CAROLEEN
TRYON
NORTH CAROLINA
SOUTH CAROLINA
GAFFNEY
CAESARS HEAD
CLIFTON
GREENVILLE
PELZER
ENOREE
SOUTH CAROLINA
GEORGIA
GREENWOOD
LAKE GREENWOOD
CLARK HILL RESERVOIR (CE)
OCONEE RIVER
SINCLAIR LAKE

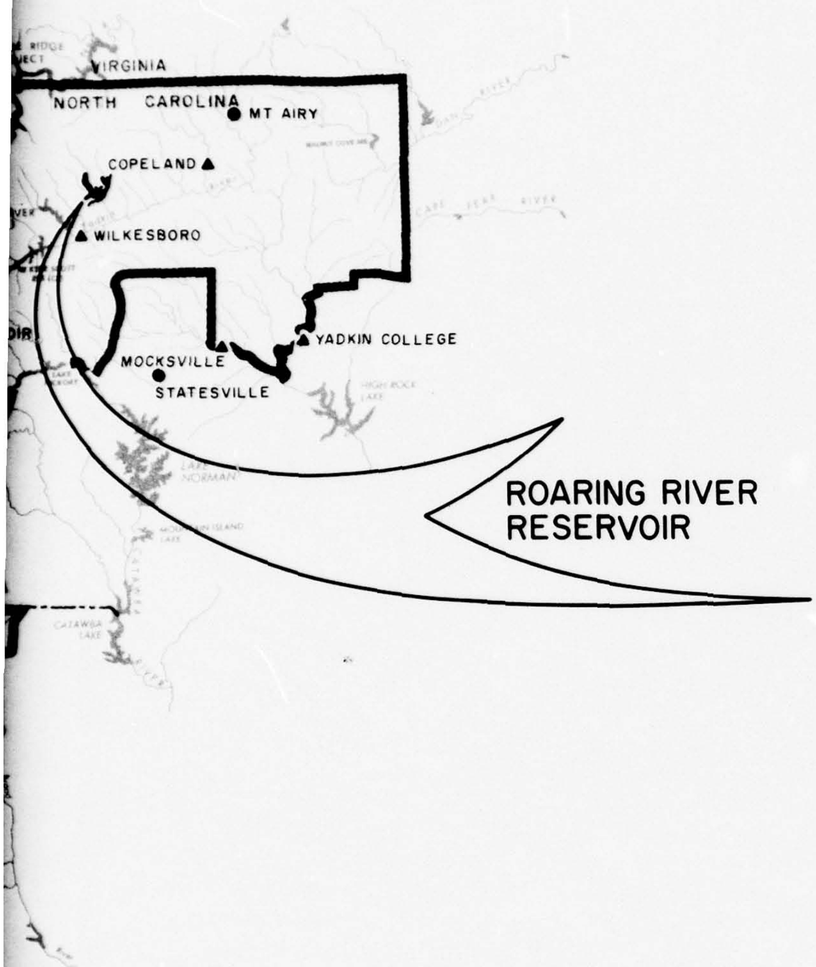


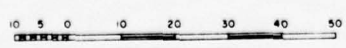
VICINITY MAP

LEGEND

● PRECIPITATION STATIONS

▲ STREAM GAGING STATIONS





REPORT FOR
DEVELOPMENT OF WATER RESOURCES
IN
APPALACHIA

ROARING RIVER RESERVOIR

HYDROLOGIC STATIONS

OFFICE OF APPALACHIAN STUDIES JUNE 1968

III-6-21 EXHIBIT 6-4

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Precipitation

Records of precipitation are available for many locations throughout the Sub-region. Practically all of the selected stations have records in excess of fifty years. Records at several locations extend back beyond 1900. Since 1940, the network of recording gages has been expanded, and the records obtained are valuable in determining the distribution of precipitation with respect to time, as well as the areal extent.

Total annual precipitation over the region is about fifty inches, with only a small portion occurring as snow. The rainfall amounts are fairly well distributed throughout the year with the largest amounts falling during the months of March, July and August. Average monthly amounts range from about 5.5 inches in July and August to about 2.9 inches in November. Monthly extremes have ranged from a maximum of 16.06 inches at Tryon, N.C., to a minimum of zero at several stations. Precipitation data for selected stations are given in table 6-4.

TABLE 6-4

PRECIPITATION IN INCHES FOR SELECTED STATIONS
ROARING RIVER RESERVOIR, NORTH CAROLINA

Station	Period of Record	Ave. Ann.	Max. Month	Min. Month	Max. Year	Date	Min. Year	Date	Snowfall Average Annual
Caroleen	1900-66	50.89	14.43	0.00	67.63	1964	34.86	1933	
Tryon	1917-66	60.74	16.06	0.11	83.50	1964	42.55	1941	5.9
Lenoir	1872-66	50.13	12.25	0.05	64.40	1945	32.46	1933	8.7
Mt. Airy	1889-66	46.50	13.37	0.00	58.69	1964	29.92	1933	9.6
Statesville 2 NNE	1901-66	48.61	10.78	0.03	69.00	1936	34.87	1941	

Snowfall

Annual snowfall over the upper Yadkin River Basin averages about nine inches. The mountain areas average from about ten to twenty inches. Seasonal totals of seventy inches or more have been recorded in some of the mountain areas. Single storm totals of 15 inches or more have been recorded.

Storms

Only general references to early storms exist, and little is known regarding their severity over the sub-region. However, it appears that hurricanes, and the tropical storms related thereto, cause the heaviest precipitation. These storms usually occur in late summer and early fall. Extra-tropical storms are not uncommon and occur in both warm and cold months. Sudden and violent thunderstorms, which usually occur in warm weather, can give up to several inches of precipitation, though they are usually highly localized.

Major Storms Experienced

Precipitation data for a number of storms which have occurred in the general vicinity of the Yadkin River Basin are recorded and analyzed in the Corps of Engineers Report entitled "Storm Rainfall in the United States, Depth-Area Duration Data". For selected storms, the date of occurrence and the estimated accumulation of rainfall for 24- and 48-hour durations and the total storm period over a 500-square mile area are shown below.

Storm	Location of Center	Depth in inches 24 hours	Depth in inches 48 hours	Total Storm
13-17 July 1916	Altapass, N.C.	16.6"	19.5"	23.8"
10-17 Aug. 1940	*Swansboro, N.C.	6.6"	8.6"	19.6"
23-28 Aug. 1908	Vade Mecum, N.C.	9.9"	13.2"	18.0"
13-18 Sept 1945	Rockingham, N.C.	9.0"	10.3"	14.8"
13-17 Aug. 1928	Caesars Head, S.C.	10.1"	11.2"	13.5"
13-16 Oct. 1914	Mt. Mitchell. N.C.	8.6"	9.7"	12.7"

*Three other major centers located in Va., N.C. and S.C.

Droughts

Drought frequencies for the upper Yadkin River Basin were investigated using one long-term rainfall station and three relatively short-term streamflow stations. Graphical and analytical techniques were employed, using, in part, procedures and methods presented in Leo R. Beard's "Statistical Methods in Hydrology." Durations exceeding one year were used to analyze the severity and frequency of droughts that have occurred in the basin, because the period of record droughts and critical hydro-periods for reservoir yield studies often exceeded intervals of one year.

Drought frequencies determined from streamflow deficiencies were developed using computed inflows to the authorized Reddies and considered Fisher River Reservoirs (Yadkin-Pee Dee River Basin). Flows

for the periods of record were grouped into two-year intervals. The minimum flows for durations of one, three, six and twelve months were determined and their frequency statistics computed and plotted. Results of these studies are shown in table 6-5, where, for each of the two stations, the five lowest flows in order of magnitude and their estimated recurrence intervals are given.

TABLE 6-5

FREQUENCY - DISCHARGE DATA FOR DROUGHTS OF RECORD
USING TWO-YEAR INTERVALS
REDDIES RIVER AND FISHER RIVER RESERVOIRS, N.C.

	1	2	3	4	5
	Mean Daily Flow in CFS for Durations Indicated				
Inflows to Reddies Reservoir (1922-1965)					
22 2-year periods					
One Month Duration (Skew = 0.0)					
Years	1930-31	1954-55	1956-57	1924-25	1934-35
Frequency*	2.1	5.2	5.2	7.6	15.5
Discharge cfs	27	31	31	33	38
Twelve Months Duration (Skew = 0.0)					
Years	1956-57	1930-31	1954-55	1926-27	1932-33
Frequency*	2.1	3.2	4.8	23.0	23.0
Discharge cfs	68	71	75	96	96
Inflows to Fisher Reservoir (1922-1965)					
22 2-year periods					
One Month Duration (Skew = 0.0)					
Years	1954-55	1956-57	1924-25	1930-31	1942-43
Frequency*	2.0	4.8	8.0	12.4	13.5
Discharge cfs	31	36	40	44	45
Twelve Months Duration (Skew = 0.0)					
Year	1956-57	1930-31	1954-55	1940-41	1934-35
Frequency*	2.0	3.2	9.0	13.0	16.0
Discharge cfs	98	102	117	122	126

* Non-Exceedence Frequency per Hundred Years.

Drought frequences determined from rainfall deficiencies were computed using rainfall data collected at Charlotte, N.C. This station is

fairly well representative of the region and has rainfall records from 1879. Annual rainfall quantities from the period of record were grouped into five-year intervals. For each group the mean minimum annual rainfall for durations of one, two, three and five years were determined and their frequency statistics computed and plotted. The five lowest values for the period of record and their estimated recurrence intervals for durations of one and five years are given in table 6-6.

A skew coefficient of zero, as shown in the frequency tables, was generally used to determine the recurrence frequency of a given event; however, skew coefficients of 0.8, and 1.6 were considered necessary for two conditions to determine the frequency curve of best fit.

Both rainfall and streamflow data indicate that the most severe long-term drought of record was the 1953-1958 drought. The non-exceedence frequency per hundred years for this drought is about 1.0 based on rainfall deficiences and from 2.0 to 2.3 based on streamflow deficiencies. The most severe short-term droughts vary depending upon location, the duration investigated and the hydrological data used. Based on rainfall data at Charlotte, N.C., the most severe drought of record occurred in 1925 when an annual rainfall of 29.71 inches was recorded. Using streamflow data, the lowest flow for a one-month duration occurred in the 1954-1955 period for Fisher River Reservoir, while the lowest one-month flow at Reddies River Reservoir occurred in 1930-1931 period.

TABLE 6-6
FREQUENCY - PRECIPITATION DATA FOR DROUGHTS OF RECORD
AT CHARLOTTE, N. C.

	1	2	3	4	5
Charlotte, N.C., Period of Record: 1879-1966 (Normal annual precipitation = 43.38")					
17 5-year periods					
Min. Mean Annual Precipitation for:					
One-Year Duration (Skew = 0.8)					
Years	1924-28	1929-33	1949-53	1939-43	1959-63
Frequency*	1.1	1.4	21.0	22.0	31.0
Precipitation - Inches	29.71	29.88	33.46	33.63	34.71
Five-Year Duration (Skew = 1.6)					
Years	1949-53	1954-58	1894-98	1909-13	1914-18
Frequency*	0.8	2.0	9.0	11.0	16.0
Precipitation - Inches	39.66	39.95	40.47	40.56	40.88

* Non-Exceedence Frequency Per Hundred Years.

Initial Losses and Infiltration

Unit hydrograph studies were made for several flood rises at selected stream gaging stations within Sub-region D. Based on those studies, initial losses varied from about 0.5 to 1.5 inches, depending upon the season of the year and antecedent conditions. These studies indicated that initial losses would average about 1.0 inch. Infiltration capacities ranged from about 0.05 to 0.50 inch per hour with 0.10 to 0.15 having the most frequent occurrence.

Runoff

Mean annual runoff in the basin varies from 14 to 22 inches. The maximum and minimum runoff recorded was 44.71 and 7.81 inches for the years 1949 and 1955, respectively. There is a wide variation of mean daily flows at any given station during a water year; but, none have experienced periods of no flow. There is a seasonal variation of monthly runoff. The winter and early spring months produce the highest runoff, while the lowest runoff occurs during the summer months. Runoff data for selected stream gaging stations in the Yadkin River Basin are given in table 6-7.

TABLE 6-7

STREAM GAGING DATA FOR SELECTED STATIONS
YADKIN RIVER BASIN, NORTH CAROLINA

Stream and Station	Period of Record	Drainage Area sq. mi.	Period of Record - Av. cfs	Inches	Maximum of Record Year	Inches	Minimum of Record Year	Inches
			NORTH CAROLINA					
Yadkin R. Wilkesboro	1903-09 1920-66	493	797	21.94	1907	42.13	1956	9.50
Fisher R. Copeland	1931-66	121	180	20.19	1949	28.27	1956	9.83
Yadkin R., Yadkin College	1928-66	2,280	2,907	17.31	1960	28.22	1956	9.03
S. Yadkin R. Mocksville	1938-66	313	331	14.35	1960	25.67	1955	8.37

Existing Improvements and their Effect on Flow Regimen

The operating W. Kerr Scott Reservoir provides enough flood control space to prevent damaging flooding immediately downstream except for

the most infrequent storms. The smaller reservoirs scattered throughout the sub-region do not materially alter the larger flows but do have some effect on the low flow regimen of the streams.

Flood Characteristics

Floods may occur during any month. The average annual runoff is high and the streamflow is well sustained throughout the year. The streams commonly have two high-water periods. The first, or major, period is from December to April, and the floods are caused by the winter and early spring rainstorms. The second period of high water is from August to October and the floods are generally caused by the hurricane-type storms that come up the Atlantic Coast. The greatest number of floods occur during the first flood period from December to April; however, the most severe floods predominantly occur in the second flood period from August to October.

Major Known Floods

No one flood produced the highest known stages in all portions of the sub-region; however, the August 1940 flood was the most widespread and generally the most severe. Seven floods have been responsible for establishing the maximum of record throughout the region. The maximum and second largest floods for each stream gaging station listed in table 6-7 are given in table 6-8.

TABLE 6-8

MAJOR FLOOD IN YADKIN RIVER FOR SELECTED STATIONS
YADKIN RIVER BASIN, NORTH CAROLINA

Stream and Station	Period of Record	Drainage Area (sq. mi.)		Date	Gage Height (ft.)	Discharge cfs
NORTH CAROLINA						
Yadkin R.	1903-09	493	(1)	14 Aug. 1940	37.6	160,000
Wilkesboro	1920-66		(2)	July 1916	34.5	116,000
Fisher R.	1931-66	121	(1)	14 Aug. 1940	18.4	27,300
Copeland			(2)	14 June 1947	15.55	16,400
Yadkin R.	1928-66	2,280	(1)	July 1916	36.3	94,300
Yadkin College			(2)	15 Aug. 1940	33.75	80,200
S. Yadkin R.	1938-66	313	(1)	3 Oct. 1929	22.6	22,000
Mocksville			(2)	17 Oct. 1964	18.23	11,800

(1) Maximum known flood
(2) Second largest known flood

Unit Hydrographs

Unit hydrographs for the Yadkin River Watershed were determined using Clark's method following the Corps of Engineers' "Hydrologic Engineering Center" procedures. Several storms were selected for study. Those which gave the best results at the gaging stations were as follows:

Reddies River 93.9 sq. mi.	Roaring River 122 sq. mi.
13-15 August 1940	30 August - 1 Sept. 1964
14-15 September 1945	7-9 August 1965
10-13 March 1952	12-14 February 1966

Mitchell River 80.4 sq. mi.	Fisher River 121 sq. mi.
30 August - 1 Sept. 1964	19-20 October 1937
12-14 February 1966	13-15 June 1947
	30 August - 1 Sept. 1964

A natural 2-hour unit hydrograph was selected from the studies for each of the streams. The natural 2-hour unit hydrographs derived at the stream gaging stations were adjusted for the respective damsites by using drainage area ratios. Unit hydrograph data are given in table 6-9, and the hydrographs are shown graphically on exhibit 6-5. Unit hydrographs representing inflow to full pool conditions were not developed for the Yadkin River watershed reservoir projects. It was concluded that this refinement was not warranted at this time due to the small reservoir areas involved.

TABLE 6-9

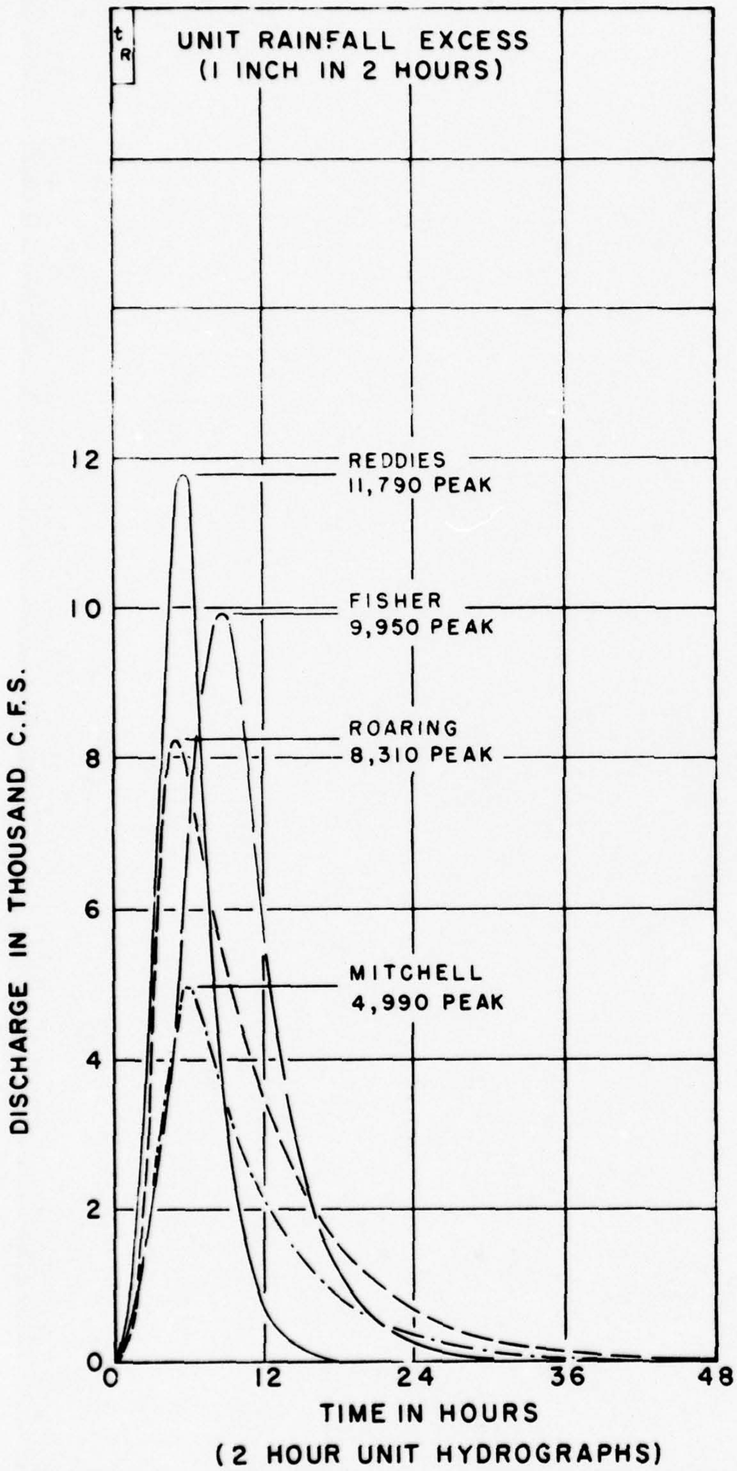
UNIT HYDROGRAPH DATA FOR RESERVOIRS CONSIDERED
IN UPPER YADKIN RIVER BASIN, NORTH CAROLINA

Factor Symbol	Reddies R. Damsite	Roaring R. Damsite	Mitchell R. Damsite	Fisher R. Damsite
Drainage Area (sq. mi.)	94.5	129	77	135
L (miles)	26	22	22	35
L_{ca} (miles)	16	12	15	23
$(LL_{ca})^{0.3}$	6.11	5.34	5.7	7.45
t_R (hours)	2	2	2	2
t_{PR} (hours)	4.5	4.0	5.0	7.5
C_{tR}	0.74	0.75	0.88	1.01
C_p	0.87	0.40	0.51	0.86
q_{PR} (cfs/sq. mi.)	123.9	64.42	64.81	73.70
Q_{PR} (cfs)	11,790	8,310	4,990	9,950
W_{50} (hours)	4.5	7.7	8.0	7.4
W_{75} (hours)	2.7	4.1	4.3	4.8
Clark constant "C"	5.0	4.0	5.0	9.0
Clark constant "R"	2.06	7.4	6.6	3.8

Flood Frequencies

Regionalized frequency studies for the Santee and Yadkin River Basins have not been made. Hydrologic-frequency evaluations were developed from an analysis of hydrological records available at stream gaging stations in the respective basins. Graphical and analytical procedures were used in developing frequency curves in accordance with methods presented in the publication, "Statistical Methods in Hydrology", by Leo R. Beard, Office of the Chief of Engineers, Department of the Army.

Yadkin River index stations selected to evaluate the economic effects of flood control storage allocated to various projects were Wilkesboro, Elkin, and Yadkin College gaging stations; and the Upper Donnaha damsite. Annual peak discharge curves were computed for natural and regulated conditions. The existing condition used for economic evaluation assumed that all floods were regulated by the existing W. Kerr Scott Reservoir. Regulated conditions were determined by routing reservoir holdouts at the various projects downstream to their respective index stations. Flood routings were performed using the successive average-lag method (Tatum), reference EM 1110-2-1408.



DAM	DRAINAGE AREA AT DAMSITE (SQ. MILES)
FISHER	135
MITCHELL	77
REDDIES	94.5
ROARING	129

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

UNIT HYDROGRAPHS
AT DAMSITES

SCALE
AS SHOWN

Drawn by: W. H. D.
Checked by: J. A. N.
Approved:
Title: Act. Chief, Proj. Plan. Br.
Date: JAN. 1968

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Due to the population distribution of the annual flood peaks of record at Wilkesboro, it was determined that a skew coefficient of +2.0 gave a frequency curve of best fit. Civil Works Investigations Project CW-152, Technical Report No. 1, dated June 1955, published a skew coefficient of +2.13 for Wilkesboro. More recent studies conducted in 1961 for the Joint Report of Land and Water Resources Study, Cape Fear River, N. C., by U.S. Soil Conservation Service, State of North Carolina, and Corps of Engineers, found skew coefficients varied from +0.1 to +2.0 using long-term gaging stations. Accordingly, a positive skew of 1.0 was adopted for frequency analyses in the Cape Fear River Basin. Therefore, it was concluded that the skew coefficients adopted for the Yadkin River were reasonable and acceptable. The skew coefficients adopted were +2.0 for Wilkesboro, +2.6 for Elkin, +1.0 for Upper Donnaha and zero for Yadkin College.

Yadkin River frequency data at the index stations are given in tables 6-10 and 6-11.

TABLE 6-10

NATURAL AND MODIFIED DISCHARGES - YADKIN RIVER
SELECTED STATIONS

	Peak Discharge-(cfs)				
	Exceedence Frequency Per Hundred Years				
Condition*	**0.5**	**1.0**	**5**	**20**	**50**
		WILKESBORO GAGE			
N	230,000	146,000	50,000	21,200	12,700
M-1	92,000	60,000	23,000	10,100	6,300
M-2(a)	17,600	15,200	10,700	6,900	4,400
		ELKIN GAGE			
N	223,000	147,000	57,500	30,000	20,600
M-1	113,000	80,000	36,000	20,500	14,900
M-2(a)	85,000	61,500	30,000	17,800	13,200
M-2(b)	77,000	56,000	27,800	16,800	12,700
M-3(c)	69,000	50,000	24,300	14,300	10,600
		UPPER DONNAHA DAMSITE			
N	143,000	115,000	66,000	41,300	27,000
M-1	98,000	81,000	50,000	32,800	22,800
M-2(a)	83,000	69,500	44,000	29,800	21,000
M-2(b)	83,000	69,500	44,000	29,800	21,000
M-2(d)	83,000	69,500	44,000	29,800	21,000
M-2(e)	77,000	64,000	40,500	27,700	19,600
M-3(c)	77,000	64,000	40,500	27,700	19,600
M-3(f)	77,000	64,000	40,500	27,700	19,600
M-3(g)	71,500	59,500	38,000	25,800	18,300
M-4(h)	68,000	56,500	36,500	25,000	17,800
M-4(i)	62,000	52,000	34,000	23,000	16,600
M-5	54,500	45,500	29,000	20,200	14,600

TABLE 6-10 (Continued)

NATURAL AND MODIFIED DISCHARGES - YADKIN RIVER

Condition	Peak Discharge-(cfs) Exceedence Frequency Per Hundred Years 0.5	1.0	5	20	50
		YADKIN COLLEGE GAGE			
N	98,500	88,500	64,500	46,200	32,000
M-1	83,000	72,500	54,000	38,300	26,800
M-2(b)	77,000	69,500	52,500	37,700	26,600
M-2(d)	77,000	69,500	52,500	37,700	26,600
M-2(e)	77,000	69,500	52,500	37,700	26,600
M-3(c)	74,500	67,000	50,500	36,200	25,700
M-3(f)	74,500	67,000	50,500	36,200	25,700
M-3(g)	72,000	65,500	49,500	35,400	25,200
M-4(h)	70,000	63,000	47,500	34,200	24,300
M-4(i)	70,000	63,000	47,500	34,200	24,300
M-5	65,500	59,000	45,500	32,700	23,300

*N - Natural
M - Modified - Reservoirs in system - number and name

1 - W. Kerr Scott
2(a) - W. Kerr Scott & Reddies
2(b) - W. Kerr Scott & Roaring
2(d) - W. Kerr Scott & Mitchell
2(e) - W. Kerr Scott & Fisher
3(c) - W. Kerr Scott, Reddies & Roaring
3(f) - W. Kerr Scott, Reddies & Mitchell
3(g) - W. Kerr Scott, Reddies & Fisher
4(h) - W. Kerr Scott, Reddies, Roaring & Mitchell
4(i) - W. Kerr Scott, Reddies, Roaring & Fisher
5 - W. Kerr Scott, Reddies, Roaring, Mitchell & Fisher

TABLE 6-11

FREQUENCY-DISCHARGE DATA (NATURAL CONDITIONS) FOR FLOODS OF RECORD - UPPER YADKIN RIVER BASIN

Location	Flood Date	Peak Discharge cfs	Exceedence frequency per 100 years
Wilkesboro Gage	Aug. 1940	160,000	0.88
Elkin Gage	Aug. 1940	170,000	0.78
Upper Donnaha Damsite	July 1916	130,000	0.68
Yadkin College Gage	July 1916	94,300	0.68

Low Flow Releases

Hypothetical reservoir routings were performed by an electronic computer using the Corps of Engineers Hydrologic Engineering Center's Program No. 23-J2-L245-"Reservoir Yield". Inflows and net reservoir losses for the critical drought periods were computed under post-project conditions for Upper Yadkin River Reservoirs. It was assumed that reservoir evaporation rates would be seventy percent of pan evaporation and post-project increases in runoff from the area of the reservoir would be about 55 percent. Minimum releases were set at about the minimum monthly flow for each site as determined from the records. For the Roaring River Reservoir it amounted to 20 cfs. No seasonal variations were considered for water supply demands or yields. Seasonal requirements used in connection with quality control were furnished by the FWPCA for critical reaches along the Upper Yadkin River. Intervening area runoff was computed and used as needed. In the Upper Yadkin River Basin, these were used only in preliminary routings to verify the adequacy of proposed storage.

Reservoir Yields

Estimated firm yields from the water supply storages recommended were based on the critical drought period of record at each reservoir site. The critical drought for Reddies and Roaring Reservoirs occurred between 1930 and 1933. Although the 1954 drought is more severe on a long-term basis and for storages greater than those recommended, the most critical periods for these reservoirs (Reddies and Roaring) are the more intense short-term drought. This short-term drought (1930 to 1933) also has a non-exceedence interval of about 50 years. With drought frequencies the same for all the reservoirs, there is about a two percent chance that a shortage will occur and that the yields would be less than those indicated. Yield versus conservation storage curves are shown on exhibit 6-1.

Water Quality Control

The beneficial water uses in the Upper Yadkin River Basin are fishing, recreation, aesthetics, and water supply. Water quality and stream uses were evaluated by the FWPCA and it was determined that coliform bacteria and dissolved oxygen were the most significant quality standards that must be maintained to protect the present and future uses of the streams in the basin. Quality standards adopted are a minimum dissolved oxygen level of 4.0 mg/l and that the coliform concentration for water supply reaches must meet the recommendations contained in the 1946 Public Health Service Bulletin No. 296.

The FWPCA found in their studies that the natural flows in the Yadkin River and treatment of waste discharges will maintain these beneficial uses until the year 2020, except in the critical reach. They recommended that 35,000 acre-feet of water quality storage be provided to increase the river's assimilative capacity in the critical reach. This will provide sufficient water for flow regulation such that there will be no more than a 5 percent chance in any given year that the dissolved oxygen level will drop below 4.0 mg/l for periods exceeding 30 days.

Routing studies conducted by this office for the critical drought period of 1954 indicate that about twice this amount of storage is required to maintain the flows recommended by the FWPCA in the critical reach below the confluence of Muddy Creek. However, this drought has a frequency of reoccurrence of less than once in 20 years, and the FWPCA standards for design are to protect the water quality with augmented flows up to the 1 in 20 year drought. Based on our studies, the 35,000 acre-feet of storage recommended by the FWPCA appears to be adequate and this value was used in allocating storages for this purpose.

In accordance with recommendations of the FWPCA (See Appendix D), this project has been evaluated on the assumption that multiple level outlets will be needed to regulate water quality releases. During advanced engineering and design, detailed water quality management studies will be made, at which time the need for a multiple level outlet will be established.

Preliminary studies indicate that a minimum flow of 20 cfs should be maintained below each damsite to assure satisfactory conditions in the river channels and streamside areas.

Flow requirements for water quality control are given in table 6-12.

TABLE 6-12

FLOW REQUIREMENTS FOR WATER QUALITY CONTROL
UPPER YADKIN RIVER BASIN, NORTH CAROLINA

Month	Flow required cfs in reach below Muddy Creek 1980	2000	2020
January	60	120	215
February	64	125	225
March	85	185	320
April	120	300	500
May	160	440	740
June	215	600	1,020
July	250	700	1,180
August	225	640	1,090
September	190	520	880
October	120	300	500
November	90	210	360
December	70	130	260

Source: Appendix D, Water Supply and Water Pollution Control, FWPCA

The conservation storage allocated to water quality control in Roaring River Reservoir, 18,000 acre-feet, was selected on the basis of project formulation studies described in Section II of this Chapter.

Water Supply

The needs for water supply were estimated to meet the needs of the basin according to benchmark goals of population and employment. The resulting estimates differ from those presented by FWPCA in Appendix D, Water Supply and Water Pollution Control. The different estimates are given below, and on the following page:

ESTIMATED MUNICIPAL AND INDUSTRIAL
GROSS WATER DEMAND (FWPCA)-mgd

	1980	2000	2020
Winston-Salem	32	70	120
Mt. Airy	6	10	14
Elkin	11	26	48
Wilkesboro	10	19	33

Source: Appendix D

ESTIMATED MUNICIPAL AND INDUSTRIAL
GROSS WATER DEMAND (CE)-(mgd)*

	1980	2000	2020
Winston-Salem	83	170	297
Mt. Airy	9	19	33
Elkin	11	26	48
Wilkesboro	10	19	33

* See Chapter 8, Part II of this report

The most pronounced differences are those at Winston-Salem and Mt. Airy where the main differences are related to the population served by each water system and to estimated per capita daily use. Variations in estimated per capita daily use can be explained by several factors: (1) assumptions regarding technological improvements and (2) water use tendencies related to community habits, water availability, quality and price. The per capita use estimates selected for use in the analysis of the Upper Yadkin Basin are similar to those used in the Southeastern River Basin Report when extrapolated to 2020. These estimates are somewhat lower than the values utilized in the Delaware River Basin Comprehensive Report and somewhat higher than the values selected by FWPCA for the Appalachian Water Resources Survey. The other main difference is related to the base area serviced by the municipal water system. This study has adopted the 1960 SMSA population as the relevant basis for projected future M&I water needs. Additional information regarding the differences in these estimates can be found in Part II, Chapters 8 of this report.

The following tabulation indicates the estimated gross water demand for Winston-Salem.

Municipal Use				Manufacturing Use (Self Supplied)			Total
Year	Pop.a/	Gallons Per Capita Per Day b/	Use (MGD)	Manuf. Employment c/	Water Use Per Employee GPD	Use (MGD)	Municipal & Manuf. Use (MGD)
1960	189,428	147	28	25,952	800	21	49
1980	271,000	170	46	37,000	1,000	37	83
2000	457,000	200	91	63,000	1,250	78	169
2020	703,000	217	153	96,000	1,500	144	297

a/ Based on 1960 Winston-Salem SMSA, actual and projected (Winston-Salem is no longer a separate SMSA)

b/ From Southeastern River Basin Report, 2020 value extrapolated

c/ Employment adjusted to reflect the percentage of employment in manufacturing utilizing company owned water sources

Approximately 94 percent of the year 2020 water supply needs of 297 mgd at Winston-Salem will be met by natural streamflow from the Yadkin River and augmented streamflow from W. Kerr Scott, Reddies River and Roaring River Reservoirs. The City of Winston-Salem presently obtains its water supply by pumping from the Yadkin River and from the storage provided by W. Kerr Scott Reservoir. A total of 244 mgd is available for present use. Allocated storage in the proposed Reddies River Reservoir will provide an additional net yield of 18 mgd for a total dependable streamflow of 262 mgd by the year 1980. An additional 35 mgd would be required to completely meet the year 2020 needs.

These needs can be met partially by Roaring River Reservoir. The net yield from the 5,160 acre-feet storage allocated to water supply in the reservoir would be 16 mgd. Thus, 278 mgd of the year 2020 gross demand will be provided, leaving an unsatisfied gross demand of 19 mgd for water supply.

The needs outlined above reflect the effects of upstream withdrawal on downstream availability. Although natural streamflow appears to be adequate to meet water supply withdrawal requirements at Wilkesboro, North Wilkesboro, Elkin and Jonesville, the additional losses resulting from greater withdrawals in the future would reduce the availability of natural streamflow at Winston-Salem, while the additional flows from releases for water supply uses at Winston-Salem will increase the dependable supply of upstream users. While the needs at Winston-Salem appear to be the critical point of needs some mechanism for basin-wide water supply management may be indicated to equitably distribute costs and administer water rights.

Flood Control

The Roaring River Reservoir will provide 48,200 acre-feet of flood control storage. This storage would control floods of record and will prevent flood releases from contributing to peaks of floods on the Yadkin River for all except very rare floods.

Sediment

Silting of the Roaring River Reservoir is considered to be similar to that anticipated for Reddies and W. Kerr Scott Reservoirs. The design sedimentation rate used in determining the amount of space to be provided was 0.45 acre foot per square mile per year. The reservoir will be fed by streams having their headwaters in the Blue Ridge Mountains, which, due to the forested conditions of the watershed, carry only small amounts of suspended materials. The U.S. Department of Agriculture in May of 1964 issued a document entitled, "Summary of Reservoir Sediment Deposition Surveys Made in the United States through 1960". Siltation data published in this report for 14

reservoirs in North Carolina show annual sedimentation rates averaging about 0.4 and ranging from a low of 0.16 to a high of 0.72 acre foot per square mile per year. In the design of W. Kerr Scott Reservoir, a rate of 0.4 AF/year/mi^2 was used. The sedimentation rate in the High Rock Reservoir on the Yadkin River near Salisbury, N.C., was measured at 0.46 AF/year/mi^2. A rate of 0.45 AF/year/mi^2 was selected as a basis for design. This is considered to be a conservative estimate and in keeping with the preliminary design of the project. Based on a project life of 100 years, the storage required for sedimentation is about 5,940 acre-feet.

Area-Capacity

The area and capacity curves for Roaring River Dam and Reservoir are shown on exhibit 6-6. They were prepared from U.S. Geological Survey advance stereo compilation prints enlarged to a scale of 1:12,000 and having a contour interval of 20 feet.

Standard Project Flood

The standard project flood for Roaring River Dam and Reservoir was not estimated. It was assumed that it would be quite similar to the one developed for Reddies Reservoir, and that the outflow from the flood would be less than that indicated at the Reddies site, due to the smaller spillway.

Spillway Design Flood

Probable maximum precipitation (PMP) estimates for the Roaring River Reservoir Project are based on the all season generalized chart developed by the U.S. Weather Bureau in Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours". The PMP values obtained from the generalized charts were reduced 13 percent to allow for basin shape as indicated in EC 1110-2-27. The PMP of 27.26 inches was determined for a storm of 48 hours duration. The six-hour rainfall values were computed and arranged in critical order of occurrence. These six-hour values were divided into 2-hour periods uniformly except for the maximum six-hour period in each day. These periods were computed and arranged in critical order of occurrence. An initial loss of 1.00 inch and an infiltration capacity of 0.10 inch per hour was subtracted from the computed rainfall amounts to derive the rainfall excess for each period. Rainfall excess amounts obtained were applied to the two-hour unit hydrograph for the reservoir to obtain the flood hydrograph. The spillway design flood has a peak of 150,600 cfs and a volume of 159,800 acre-feet, equivalent to 23.23 inches of runoff from the contributing drainage area of 129 square miles. The hyetograph of the storm and the inflow hydrograph are shown on exhibit 6-7.

Spillway Width Versus Embankment Height

An uncontrolled saddle spillway located in a ravine about 2,000 feet east of the dam (See Exhibit 6-11), was selected as the type most suited to site topography and operational requirements. An uncontrolled spillway was selected due to its lesser cost. The selection of the physical dimensions of the spillway is dictated to a large extent by the configuration of the site and its geology. It was not considered necessary to make extensive routings comparing spillway width with height of embankment.

Proposed Spillway

The proposed spillway would be a 200-foot wide uncontrolled ogee weir with a crest elevation of 1092.0 feet. A profile of the spillway and a section along the crest is shown on exhibit 6-11.

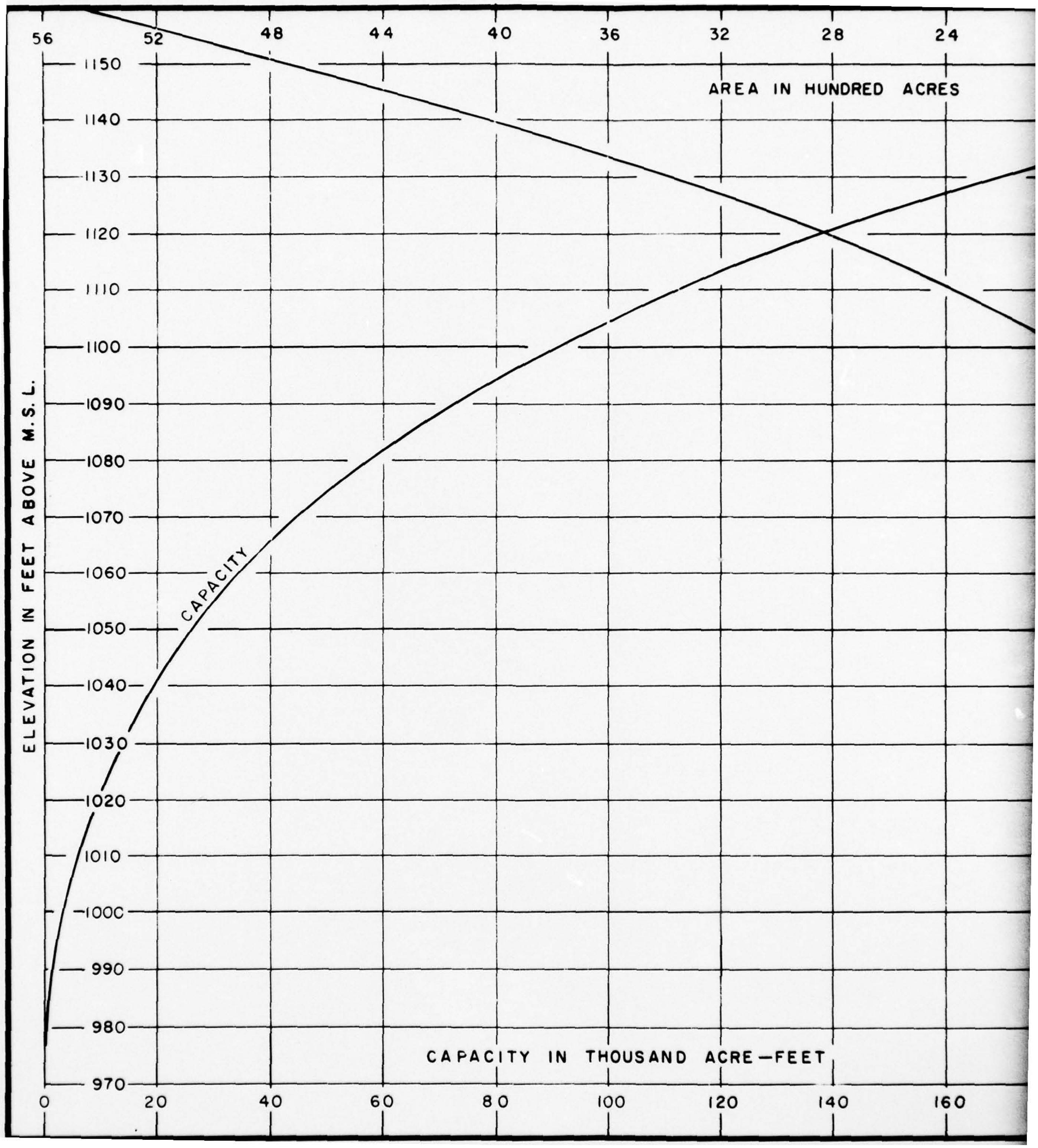
Tailwater Rating Curve

A tailwater rating curve was computed for the Roaring River damsite by using the rating curve for the gaging station and extending it for higher flows by the slope-area method. The rating curve is presented on exhibit 6-8.

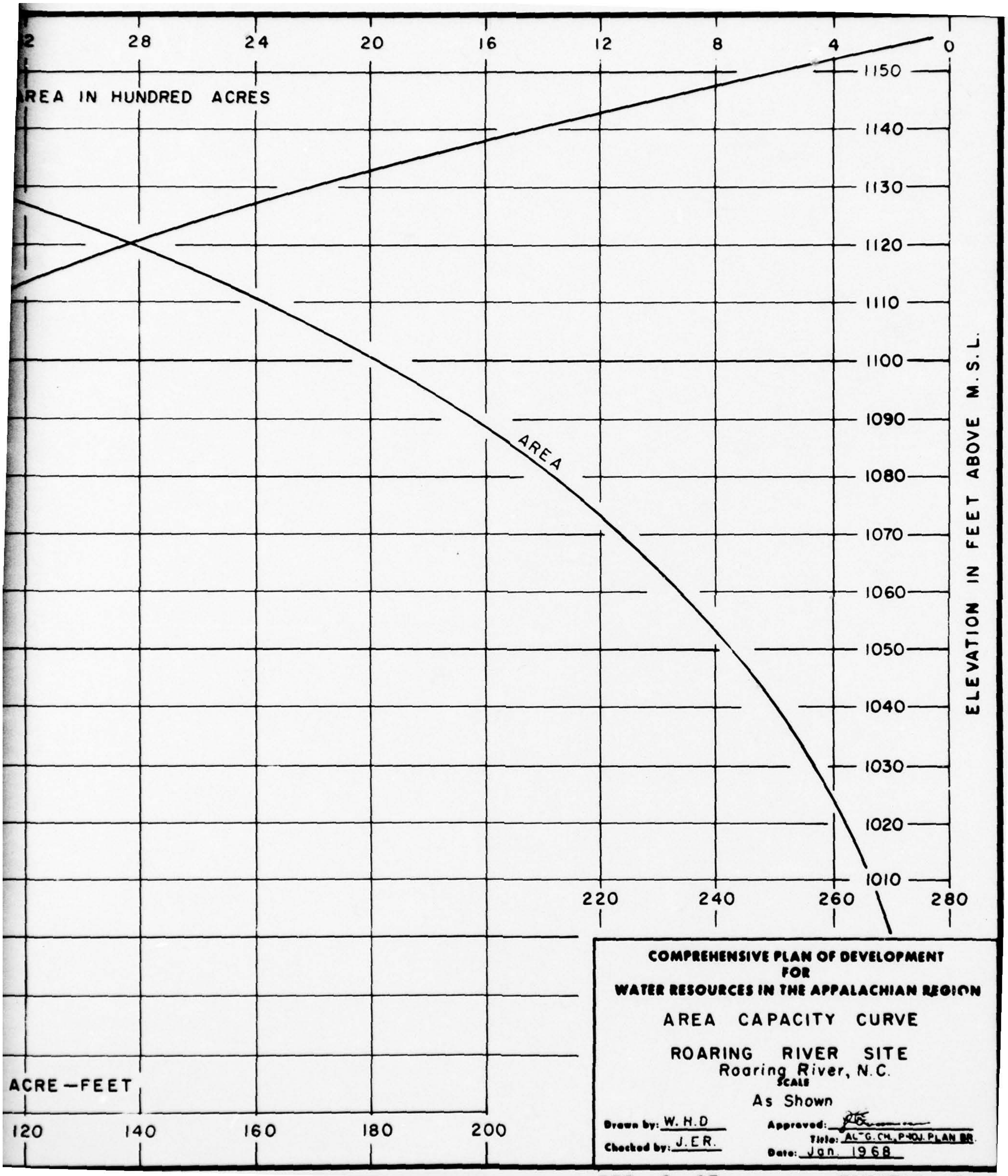
Outlet Works

A nine-foot diameter reinforced concrete conduit with a multi-level intake tower would be used to make all releases at or below the top of flood control pool. At this elevation, 1092.0 feet, the design capacity is 3,800 cfs. Conditions considered in selecting the size of the conduit were predicated on channel capacities downstream of the dam and time required to empty the flood control pool. The conduit selected would empty the flood control pool in about a week and could be used for flood control releases at the same time the spillway is in operation. The downstream channel capacity is about 3,000 cfs. It is proposed to establish definite channel capacity from backwater profiles to be made during design stage studies.

The proposed outlet works is considered adequate to provide emergency evacuation of the reservoir for the following reasons. The outlet capacity will handle expected flood series of several combinations which might occur. For example two storms, separated by four days, which would produce 3.00 inches of runoff in the first period and 7.00 inches in the second period would empty the flood control storage in 3-1/2 days during the first period and 7-1/2 days in the second period. The flood control storage provided in the Roaring River Reservoir is about twice the storage required to control the known flood of record. The time required to empty the conservation pool down to the top of sediment pool is about 4-1/2 days. The channel capacity of the Yadkin River at the mouth of the Roaring River is about 15,000 cfs. Due to the flashy flood characteristics of the Yadkin River and its tributaries, uncontrolled major floods below W. Kerr Scott Reservoir will not generally prevail more than 24 hours. Therefore, flood releases from the Roaring River Reservoir will not normally be restricted by high stages in the Yadkin River.



AREA IN HUNDRED ACRES
56
52
48
44
40
36
32
28
24
CAPACITY
ELEVATION IN FEET ABOVE M.S.L.
1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
CAPACITY IN THOUSAND ACRE-FEET
0
20
40
60
80
100
120
140
160



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

AREA CAPACITY CURVE

ROARING RIVER SITE
Roaring River, N.C.

SCALE
As Shown

Drawn by: W. H. D
Checked by: J. E R.
Approved:
Title: AL^G. CH., PROJ. PLAN BR.
Date: Jan. 1968

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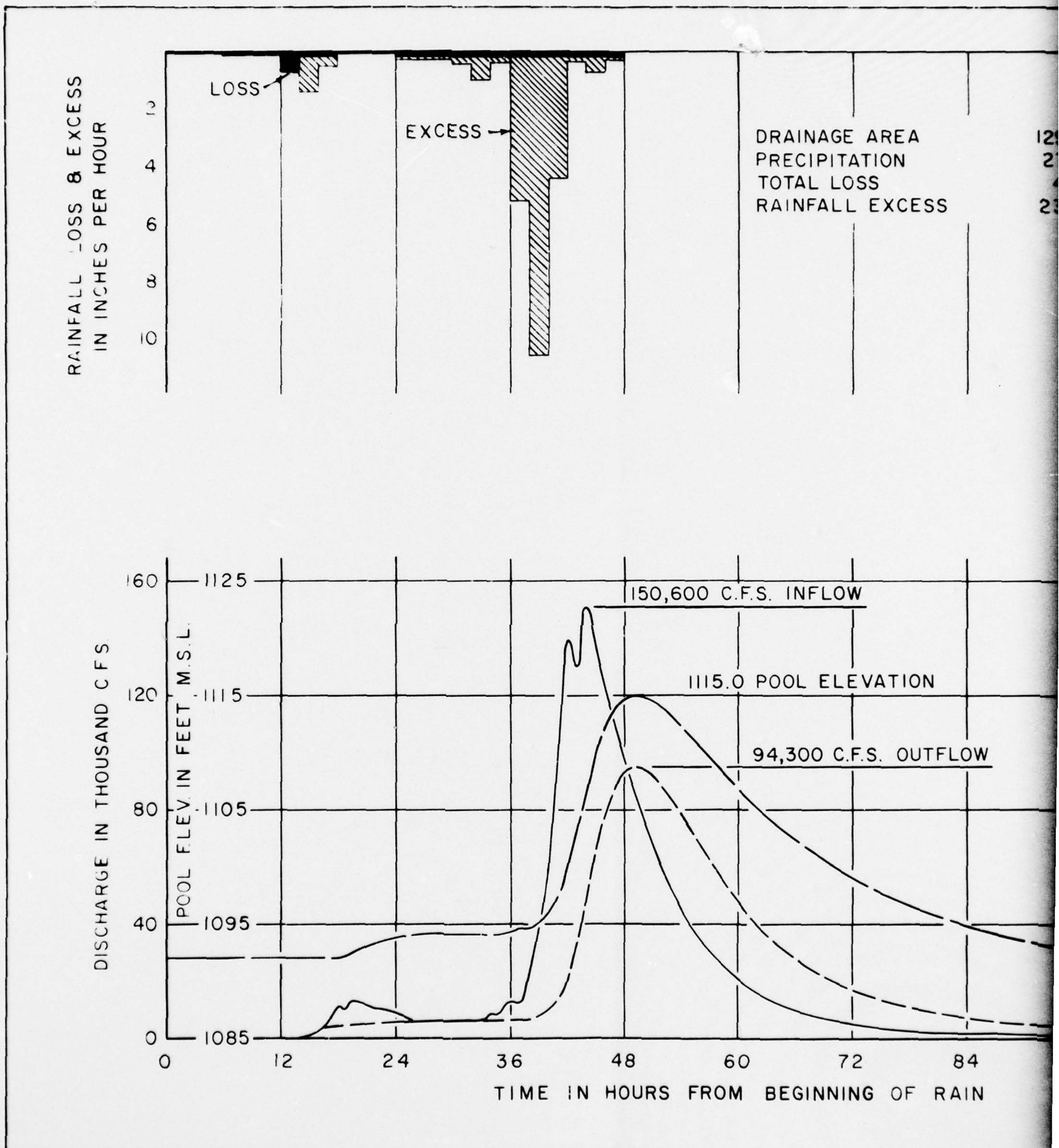

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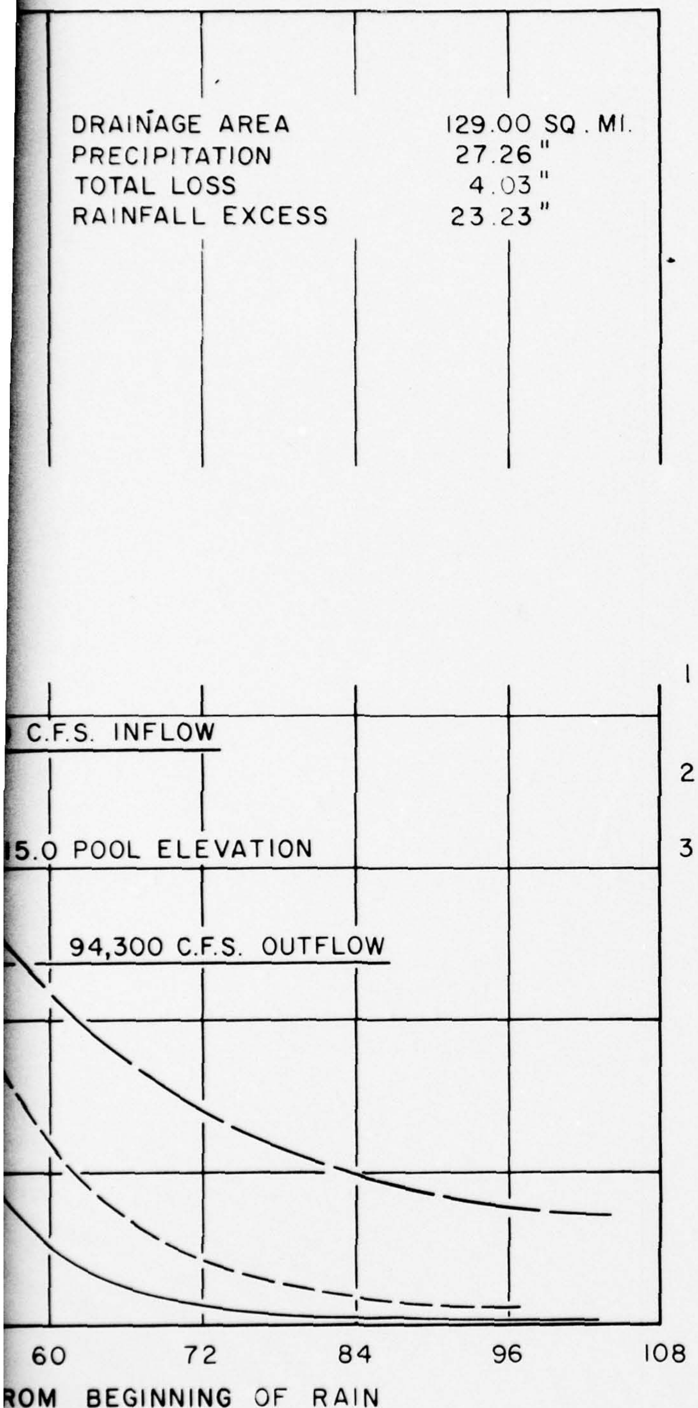

NOTES

1. RESERVOIR FULL TO ELEVATION 1092.0 (TOP OF FLOOD CONTROL POOL) AT BEGINNING OF FLOOD.
2. SADDLE TYPE UNCONTROLLED SPILLWAY WITH CONCRETE OGEE CREST 200.0'
3. SPILLWAY CREST ELEVATION 1092.0

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
ROARING RIVER SITE
RESFRVOIR INFLOW-OUTFLOW HYDROGRAPHS
FOR SPILLWAY DESIGN FLOOD
ROARING RIVER, N.C.
SCALE
AS SHOWN

Drawn by: W.T.J. Approved: [signature]
Checked by: J.E.R. Title: Act. Chief, Proj. Plan. Br
Date: JAN 1968

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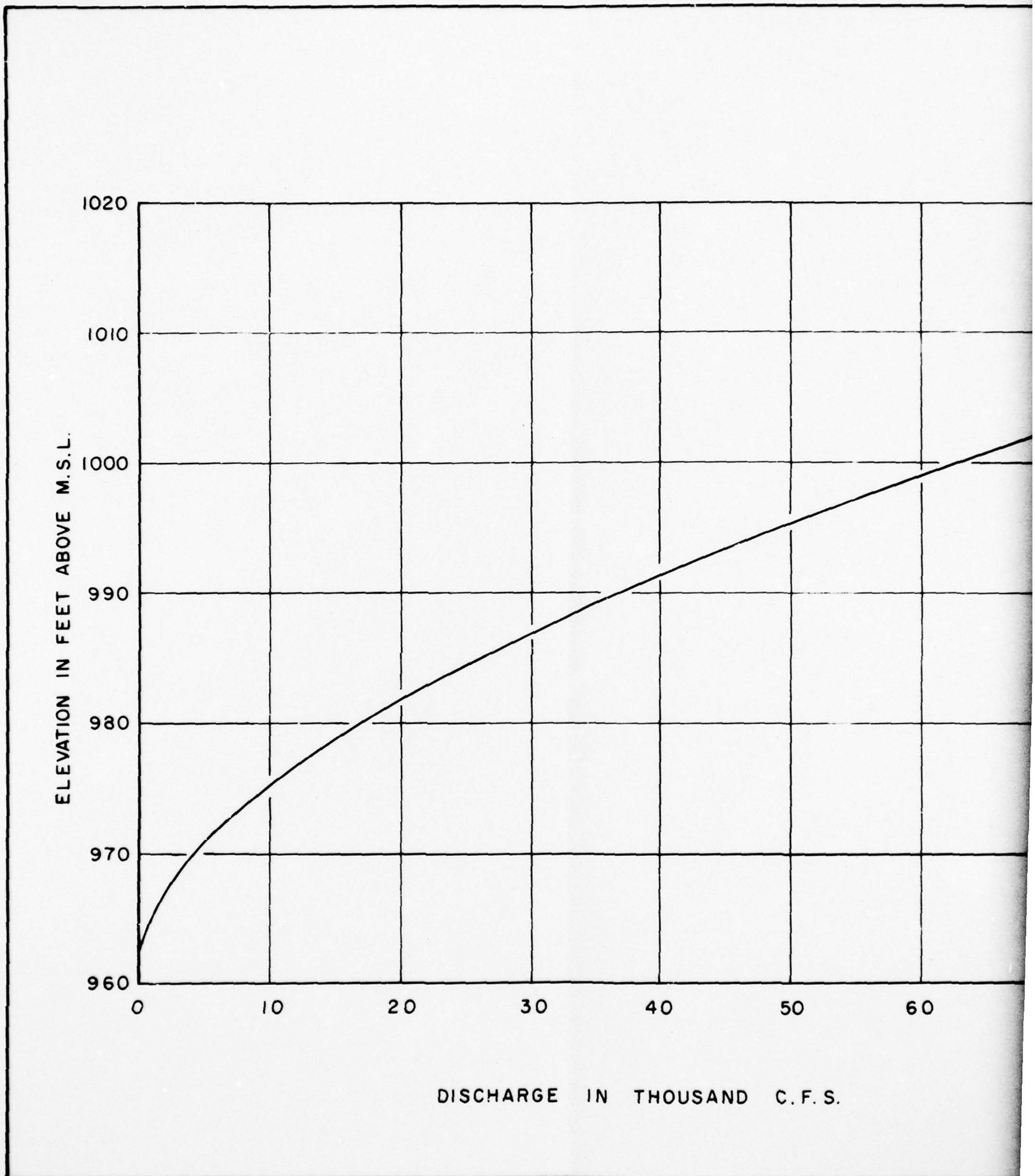

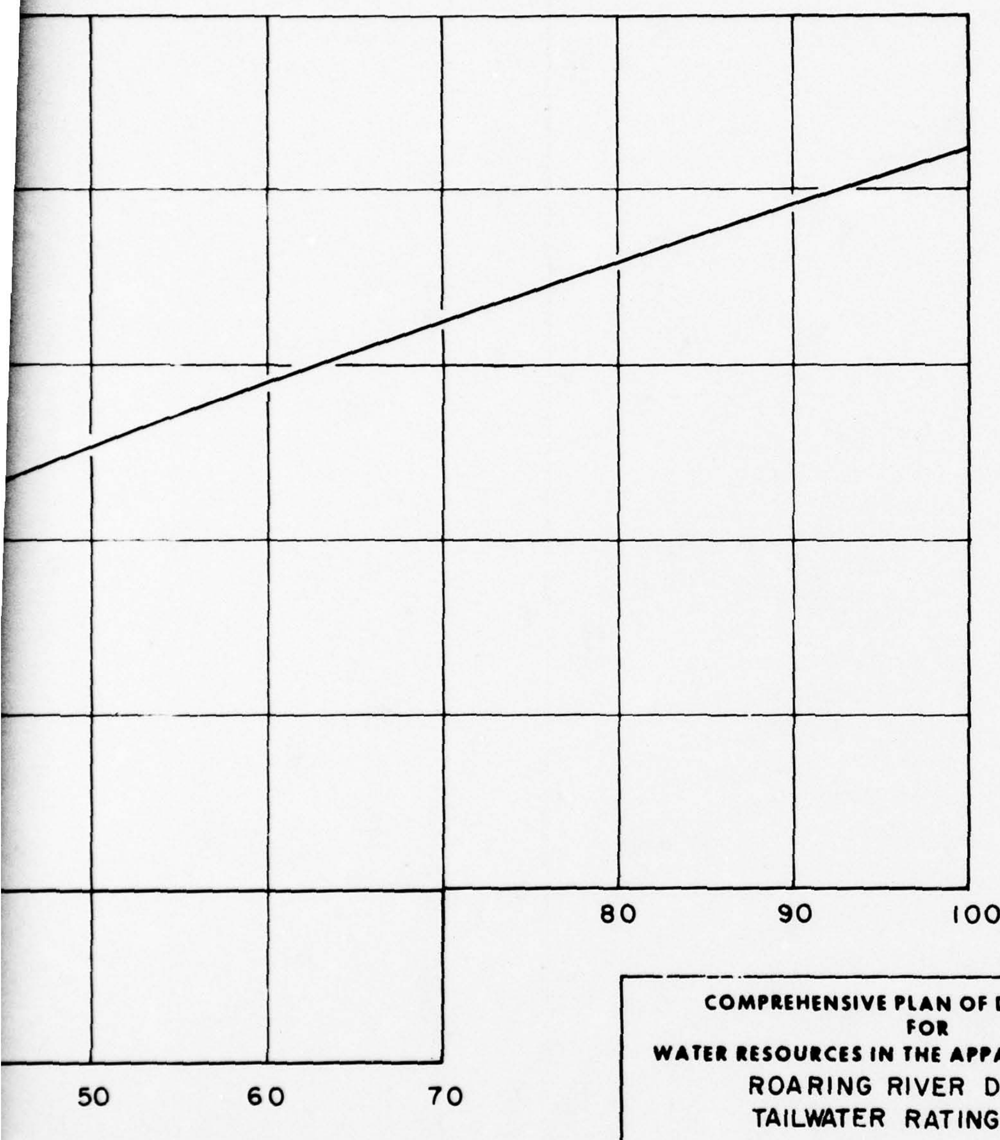

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
ROARING RIVER DAM SITE
TAILWATER RATING CURVE

ROARING RIVER, N.C.

SCALE
AS SHOWN

Drawn by: W. T. J.
Checked by: J. E. R.
Approved:
Title: Act. Chief, Proj. Plor. Br.
Date: JAN 1968

 EXHIBIT 6-8

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Flood Routing Conditions

An uncontrolled spillway is proposed for the Roaring River Dam and Reservoir project. Since sufficient storage is allocated to provide a very high degree of flood control by this reservoir, the reservoir level was assumed to be at the top of the conservation pool at the beginning of storm runoff for the routing of all floods except the spillway design flood. For the spillway design flood, the reservoir level at the beginning of the flood was at the top of the flood control pool. The conduit gates were fully open during the spillway design flood after uncontrolled flows through the spillway exceeded the downstream channel capacity to limit surcharge storage. While flood releases are expected to be large enough to permit rapid emptying of the reservoir, the condition that the flood control space be filled at the beginning of the spillway design flood was assumed in order that the top of the dam be established at a conservatively high elevation.

Flood Routing Results

Seven inches of flood control storage would be provided. With this amount of storage, all the floods of record could be completely stored and later released at a time and rate which will not contribute to downstream flooding. Only with the very large and infrequent floods (those approaching the standard project flood in magnitude) would floodwaters occupy the surcharge storage and flow over the spillway. The effect Roaring Reservoir has on flows at four index stations on the Yadkin River is shown in table 6-10.

Spillway Design Flood

The spillway design flood was routed through the reservoir by the Modified Puls method. The flood control space was assumed to be filled at the beginning of the flood. The maximum reservoir elevation and outflow attained in the routing were 1115.0 ft. msl and 94,300 cfs, respectively. Maximum surcharge storage reached 49,500 acre-feet or 23 feet above the spillway crest elevation of 1092.0 feet. Reservoir inflow-outflow hydrographs for the spillway design flood are shown on exhibit 6-7.

Reservoir

Roaring River Reservoir, as a unit in the system with Reddies and the existing W. Kerr Scott Reservoirs, will be operated to reduce flooding to within acceptable limits and to provide water supply, water quality control, and the basis for recreational development of the Upper Yadkin River watershed. Impoundments and releases at all the reservoirs will be determined on the bases of system needs and requirements and conditions, at various control points within the watershed above Yadkin College. Although areas below Yadkin College are beyond the effective control of these reservoirs, care will be taken not to aggravate local conditions below Yadkin College by their operations. Pertinent data for the Roaring River Project are shown in table 6-13.

TABLE 6-13

ROARING RIVER DAM AND RESERVOIR
PERTINENT DATA

DRAINAGE AREA 129 SQ. MI. (1.00" Re - 6,880 A.F.)

Feature	Elev. (ft. msl)	Surface Area (acres)	Total Capacity (ac. ft.)	Allocated Capacity (ac. ft.)	Runoff (Inches)
Top of dam	1120.0				
Max. Water Surface	1115.0				
					10.83
Top of FC Pool	1092.0	1,740	77,300		
				48,200	7.00
Top of Cons Pool	1053.0	821	29,100		
Water Supply				5,160	0.75
Water Quality				18,000	2.62
Sediment Pool			5,940		0.86
Stream Bed	961.0				

SPILLWAY

Saddle type with concrete ogee crest uncontrolled	
Crest elevation	1092.0 ft.
Crest length	200 ft.
Length of Spillway Channel	1,700 ft.

OUTLET WORKS

Concrete-conduit lined tunnel with shafts	
Multiple level intake tower	
Tunnel diameter	9.0 ft.
Tunnel length	750 ft.
Tunnel invert elevation at entrance	961.0 ft.

SPILLWAY DESIGN FLOOD

Total volume of rainfall, inches	27.26
Total volume of runoff, inches and acre feet	23.23 - 159,800
Peak inflow, cfs	150,600
Peak outflow, cfs (90,300 through spillway)	94,300

Control Points

The primary control points that will influence flood control releases, and data associated with each, are presented in the following tabulation:

Location	Flood Stage	Max. Ft.	Known Stg. Date	Est. Discharge at Flood Stage cfs	Approx. Travel Time Between Stations (hours)
Wilkesboro	12.0	37.6	14 Aug. 1940	7,200	-
Elkin	18.0	37.5	Aug. 1940	16,500	9
Enon*	-	-	-	-	-
Yadkin College	18.0	36.3	Jul 1916	23,400	31

* Currently measures only low and medium flows; will recommend that a digital water stage recorder be installed.

Flood control releases from the reservoirs will utilize flood forecasts and will be at rates so that optimum flood control benefits may be achieved. Releases for water quality control and water supply will be made in accordance with the required demands.

Release Limitations

Flood releases from any of the reservoirs will be withheld until there is no danger of adding to peak flood flows generated from the uncontrolled drainage area downstream. Due to the large residual drainage area, streamflow will be withheld for several days or as long as it is prudent to do so in order to achieve maximum flood control benefits at distant downstream points.

Reservoir Regulation Effects

The effects the system of reservoirs will have upon the area is outlined by the following stated project purposes.

Flood Control. The Upper Yadkin River Valley between the Upper Donnaha index station and W. Kerr Scott Dam is mostly rural with about ten small communities located along the river. The valley between the Upper Donnaha index station and Yadkin College is essentially rural but does have one small community located along the river. Two of the communities have populations between 2,000 and 5,000 while the others are below 2,000. Each is subject to flooding to some degree but the major urban damage centers are: Wilkesboro, North Wilkesboro, Roaring River, Elkin and Jonesville. Farm lands in the flood plain are used for pasture and to grow corn, tobacco, soy beans, wheat, oats

and hay, with corn being the major crop. Flooding along the river results in damage to industrial and urban facilities, farm buildings, crops, livestock, mills, highways, railroads and bridges.

The system of reservoirs (W. Kerr Scott, Reddies River and Roaring River) will have a total of about 195,000 acre-feet of flood control storage available. This is sufficient to contain all the floods of record at the damsites and to essentially eliminate or significantly reduce those at damage centers below the reservoirs. The effects each of the reservoirs, individually and as a system, will have upon the stage frequency curve is illustrated in exhibit 6-9, the natural and modified frequency curve for the Elkin index station. Although only one curve is included as an exhibit, similar curves were derived for the gaging stations at Wilkesboro, Upper Donnaha and Yadkin College. The effects the reservoirs have at each of these stations are shown in table 6-10. The system of reservoirs has its most pronounced effect on stages and flows between the Upper Donnaha and Wilkesboro stations. Below the Upper Donnaha station, the effects of the reservoirs diminish as the distance downstream increases.

Water Quality. The operating schedule for Roaring River Reservoir would allow releases to be made from the 18,000 acre-feet of space allocated for water quality improvement along the Yadkin River downstream to High Rock Lake. Reservoir releases will be coordinated with releases from Reddies River Reservoir to permit optimal beneficial effects in the critical reaches of the Yadkin River. As previously indicated, about 5,000 acre-feet of additional water quality storage should be allocated to the system of reservoirs in advanced engineering and design to meet the needs to 2020.

Water Supply. Reservoir releases will be made from the 5,160 acre-feet of space allocated for water supply on request from the users who are anticipated to withdraw the additional flows at downstream points. An additional 16 mgd should be available to downstream users from Roaring River Reservoir, according to historical records and depending on reservoir inflows.

Minimum Releases

Minimum releases will be made from the reservoir to protect riparian users' rights to natural streamflow. A minimum release schedule of 20 cfs is anticipated, based on recorded minimum monthly flows. However, in the event of more serious deficiencies in inflow, minimum releases would be adjusted to pass inflow.

Hydrologic Network

A hydrologic network will be established to obtain: (a) current reporting of precipitation data; (b) records of reservoir inflow and

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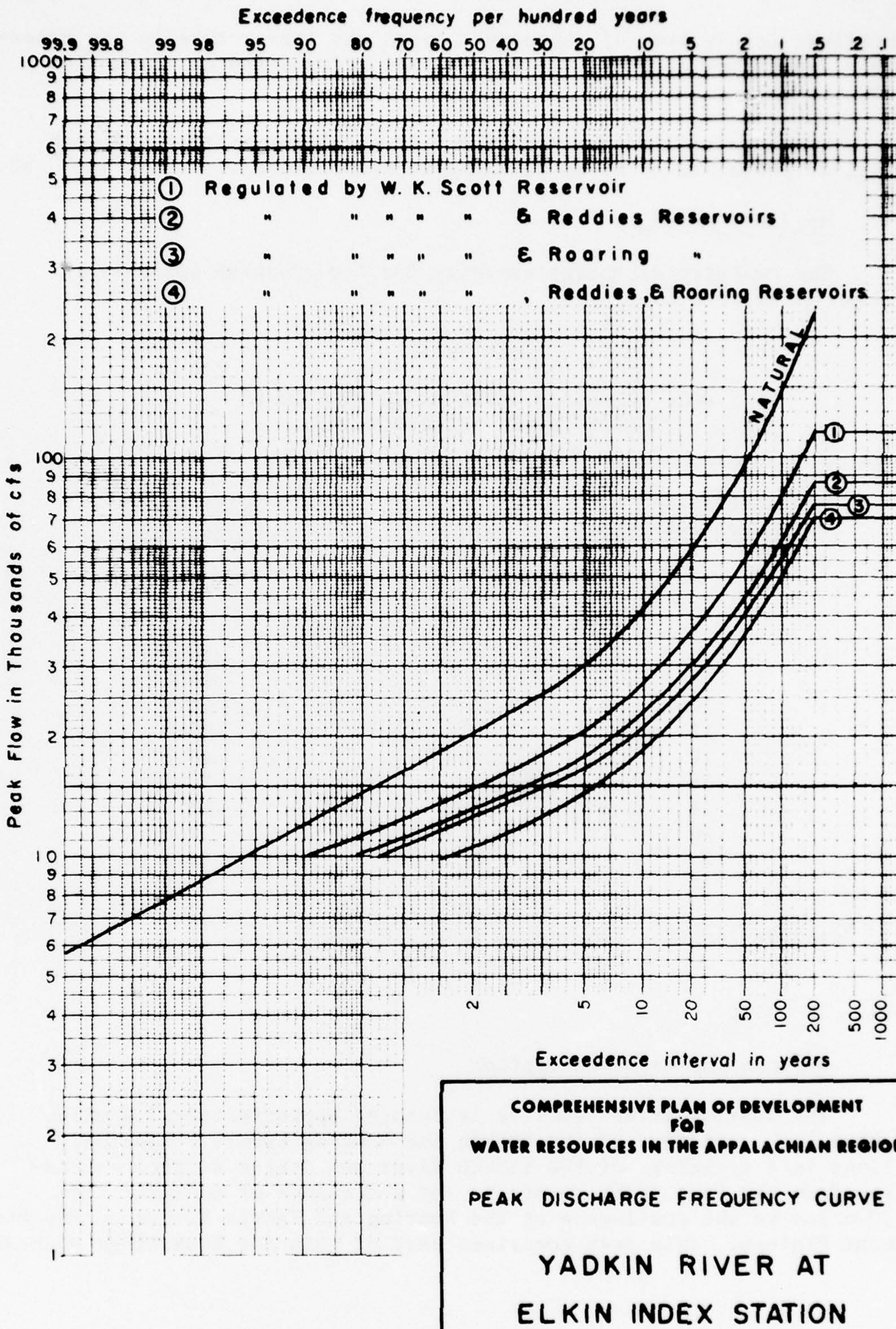


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

PEAK DISCHARGE FREQUENCY CURVE

YADKIN RIVER AT
ELKIN INDEX STATION

outflow; (c) records of dissolved oxygen and temperature in the reservoir and in the outflow; and (d) current information on streamflow downstream.

Stations required to supplement those of the existing network will be installed at sites selected in cooperation with USGS and USWB.

Spillway Ratings

The computed discharge capacity for the proposed spillway is given in table 6-14.

TABLE 6-14

POOL ELEVATION - DISCHARGE RELATION[a/]
ROARING RIVER RESERVOIR, N.C.

Pool Elevation above spillway crest	Discharge (1,000 cfs)
0	0
2	1.7
4	5.1
6	10.0
8	16.0
10	23.1
12	31.3
14	40.3
16	50.5
18	61.2
20	72.6
22	84.6
24	96.9

a/ Spillway length - 200 feet; elevation 1092 msl.

11. GEOLOGIC

Surrounding Area Description

The Roaring River Dam site is located approximately 2.9 miles above the confluence of the Yadkin and Roaring Rivers. Roaring River is a tributary of the Yadkin River and drains an area extending from the Blue Ridge Mountains for a distance of approximately 20 miles to the confluence of the Roaring and Yadkin Rivers on the Piedmont Plateau. This area comprises part of both the Blue Ridge Mountain

and the Piedmont physiographic unit. The reach of the Roaring River from the mouth of its East Prong to the Yadkin River, is entirely within the Piedmont province. This reach of river transacts the lithologic Brevard zone as determined from field reconnaisance. The proposed damsite is located in the Brevard. Topography of the area consists generally of rolling hills with steep narrow valleys. Slopes of the abutment of the damsite investigated are approximately one vertical on three horizontal. Drainage features are primarily perpendicular to the Blue Ridge Front; however, lineaments parallel to the Brevard belt, striking about north six degrees east, are common. Maximum relief is approximately 300 feet with elevations varying from 950 to 1250 feet.

Area Geology

The Brevard zone is a belt of low grade metamorphic rocks, predominantly schist, extending from Alabama northeastward into Virginia. It is less than five miles wide, and is bordered by metamorphic rocks of medium to high grade. Generally, the zones separate the Blue Ridge province from the Piedmont province; however, in this area it is entirely within the Piedmont province.

The Brevard is a major tectonic (rock formation) feature. The exact nature of the deformation in the zone is somewhat uncertain; however, it can be asserted that some type of faulting has played a significant role in its geologic history. Butler and Dunn (1965, page 3) suggest the possibility of fault movement along the Brevard zone in North Carolina during the Pleistocene and recent periods of geologic time and are currently investigating supporting evidence. Four earthquakes have been recorded with epicenters 50 miles or less from the damsite. The nearest was 24 miles away. Intensity of these quakes was relatively mild, ranging from IV to VI on the modified Mercalli scale. No evidence of fault movements in recent geologic time has been observed in the near vicinity of the damsite. A study of the earthquake history of this region indicates a propensity for relatively frequent minor tremors, but very little tendency for high-intensity quakes. Earthquakes should not pose a serious problem to the construction or function of a dam at the proposed site.

Site Geology

Weathering at the damsite is variable, but is generally deep (50 to 100 feet) in upland areas and abutments, and quite shallow in the river valley. Overburden in upland areas and abutments consists of 20 to 45 feet of residual soil classified as silty clay and clayey silt. The river valley has been stripped of overburden and most of the weathered rock. The one boring in the valley encountered fresh, sound rock at a depth of less than 5 feet.

The predominant rock type in the damsite area is chlorite schist. It is a lustrous, grey to green, chlorite, quartz, sericite schist locally containing numerous garnets and sometimes graphite. Quartz stringers with fine, granular textures are common and thin layers or lenses of gneiss are sometimes present in the schist. The shistosity and foliation strike northeast and dip 50 to 80 degrees to the southeast.

Sub-surface investigations pertinent to this site consist of 7 core borings, 6 on the left bank and one in the abutment area of the right bank. The location and logs of these borings are shown in exhibit 6-10.

Earth and rock excavated from the spillway will be used in the construction of the embankment. From preliminary estimates, it appears that the amount of material produced from site excavation will be insufficient to complete the dam. Residual soils of an impervious type suitable for rolled-fill construction occur in great abundance in the areas adjacent to the site.

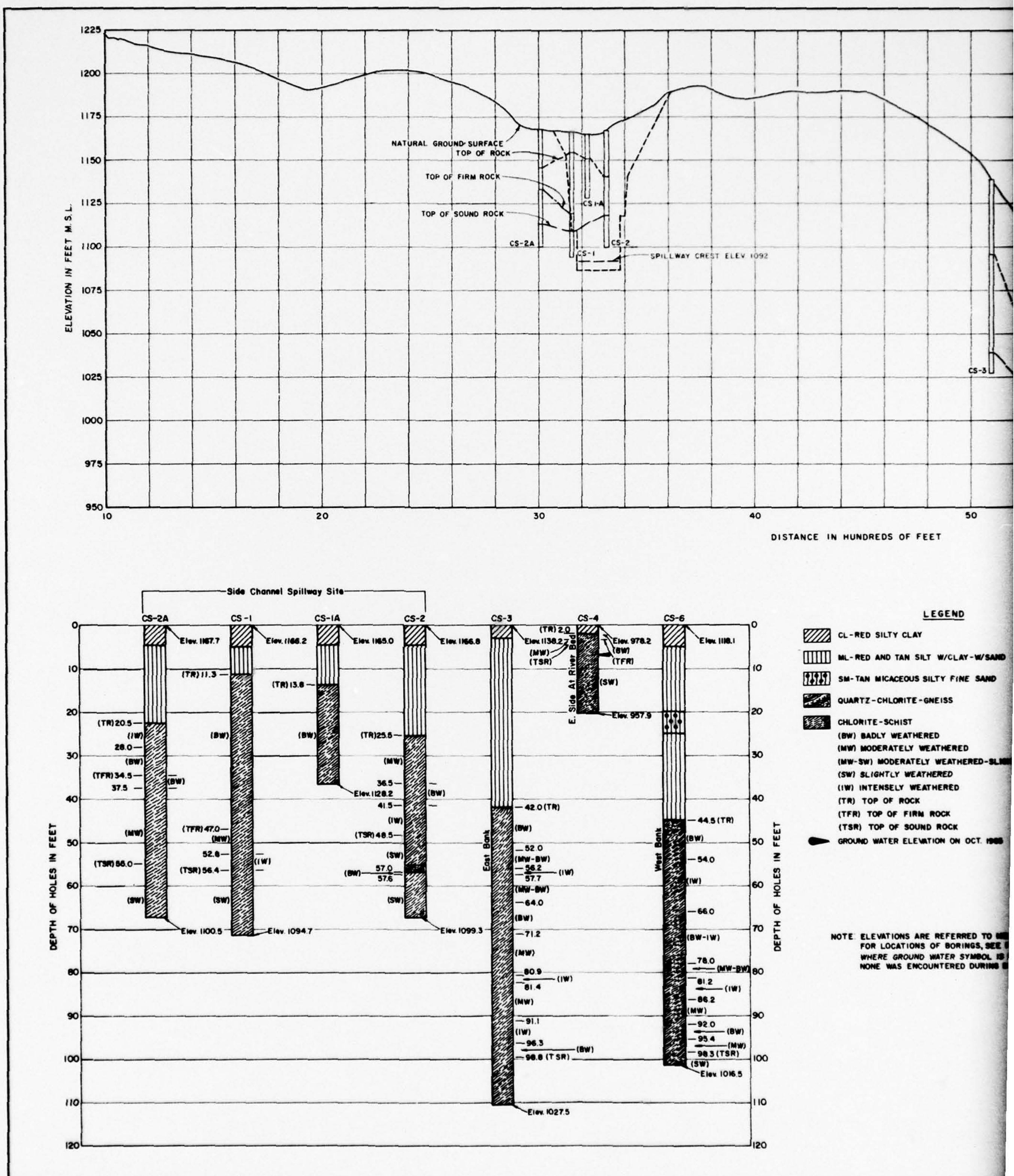
Conclusions

From the preliminary geological investigation that has been made, it appears that foundation conditions at the site are satisfactory for the construction of an earth-type dam.

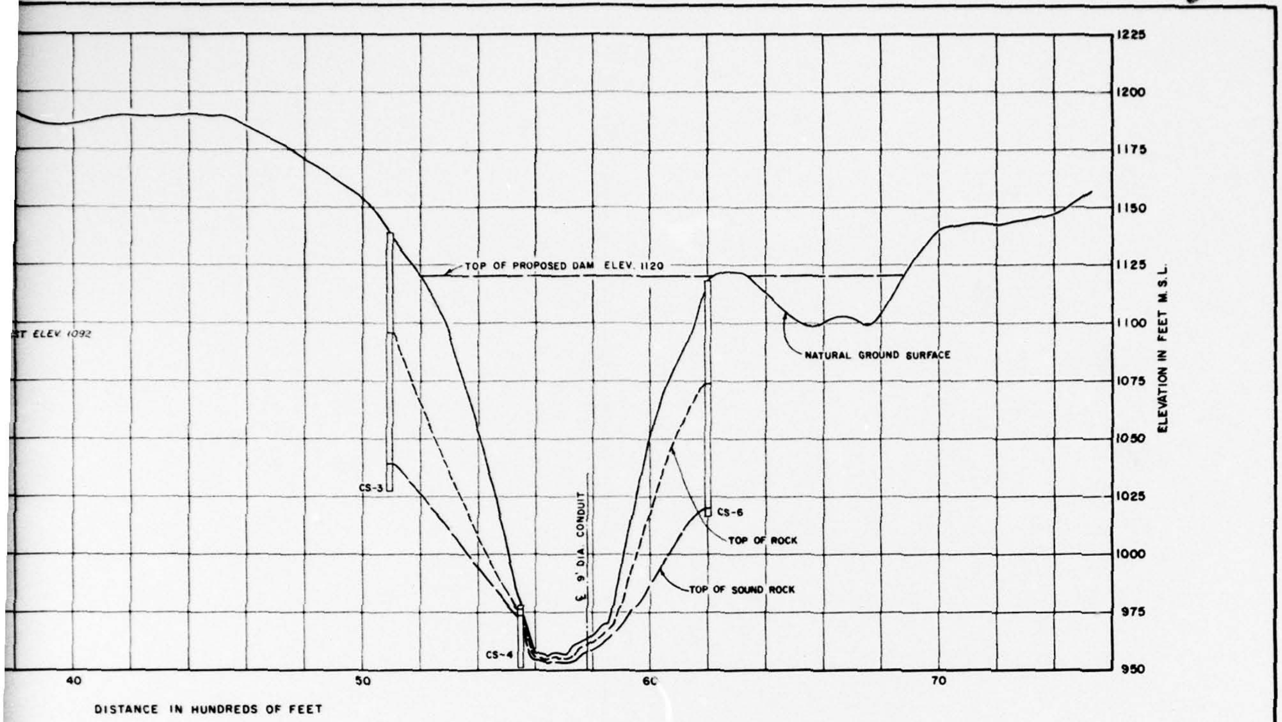
12. STRUCTURAL

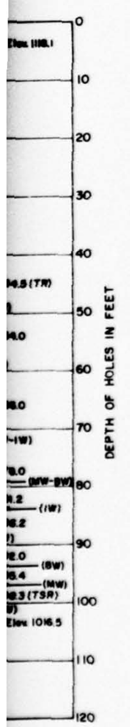
Structural features are shown on exhibit 6-11. The rolled earth and weathered rock dam will be built of selected materials from required excavation and from borrow areas. The dam would have a length of 970 feet. Maximum height of the dam would be 159 feet above the stream bed, with top elevation at 1120 feet, five feet above the spillway design flood. A horizontal and an inclined sand drain will be incorporated in the downstream portion of the fill. A dike, about 500 feet long, with slopes similar to the dam will be built in the saddle 120 feet west of the dam.

The spillway would be located in the saddle about 1,600 feet east of the dam. Water would be discharged into a tributary creek which would return to the flow to the Roaring River about 1,300 feet downstream from the toe of the dam. The uncontrolled spillway crest elevation would be 1,092 feet, with a concrete ogee control section, and excavated into firm rock. The spillway would be designed to carry a discharge resulting from a maximum reservoir level of elevation 1,115 feet.



ELEVATION IN FEET M.S.L.
DISTANCE IN HUNDREDS OF FEET
NATURAL GROUND SURFACE
TOP OF ROCK
TOP OF FIRM ROCK
TOP OF SOUND ROCK
CS-2A
CS-1
CS-1-A
CS-2
CS-3
SPILLWAY CREST ELEV. 1092
Side Channel Spillway Site
CS-2A
CS-1
CS-1A
CS-2
CS-3
CS-4
CS-6
DEPTH OF HOLES IN FEET
Elev. 1167.7
Elev. 1166.2
Elev. 1165.0
Elev. 1166.8
Elev. 1138.2
Elev. 978.2
Elev. 1118.1
Elev. 1100.5
Elev. 1094.7
Elev. 1128.2
Elev. 1099.3
Elev. 1027.5
Elev. 957.9
Elev. 1016.5
East Bank
West Bank
E. Side At River Bed
LEGEND
CL-RED SILTY CLAY
ML-RED AND TAN SILT W/CLAY-W/SAND
SM-TAN MICACEOUS SILTY FINE SAND
QUARTZ-CHLORITE-GNEISS
CHLORITE-SCHIST
(BW) BADLY WEATHERED
(MW) MODERATELY WEATHERED
(SW) SLIGHTLY WEATHERED
(IW) INTENSELY WEATHERED
(TR) TOP OF ROCK
(TFR) TOP OF FIRM ROCK
(TSR) TOP OF SOUND ROCK
GROUND WATER ELEVATION ON OCT.
NOTE: ELEVATIONS ARE REFERRED TO
FOR LOCATIONS OF BORINGS, SEE
WHERE GROUND WATER SYMBOL IS
NONE WAS ENCOUNTERED DURING





LEGEND

- CL-RED SILTY CLAY
- ML-RED AND TAN SILT W/CLAY-W/SAND
- SM-TAN MICACEOUS SILTY FINE SAND
- QUARTZ-CHLORITE-GNEISS
- CHLORITE-SCHIST

(BW) BADLY WEATHERED
(MW) MODERATELY WEATHERED
(MW-SW) MODERATELY WEATHERED-SLIGHTLY WEATHERED
(SW) SLIGHTLY WEATHERED
(IW) INTENSELY WEATHERED
(TR) TOP OF ROCK
(TFR) TOP OF FIRM ROCK
(TSR) TOP OF SOUND ROCK
GROUND WATER ELEVATION ON OCT. 1965

NOTE: ELEVATIONS ARE REFERRED TO MEAN SEA LEVEL.
FOR LOCATIONS OF BORINGS, SEE PLATE
WHERE GROUND WATER SYMBOL IS NOT INDICATED, NONE WAS ENCOUNTERED DURING DRILLING.

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROARING RIVER DAM SITE
SITE CROSS SEC. & BORING LOGS

ROARING RIVER, NORTH CAROLINA
SCALE
AS SHOWN

Drawn by: L.W.S. Approved: [signature]
Checked by: J.E.R. Title:
Date: JANUARY 1966

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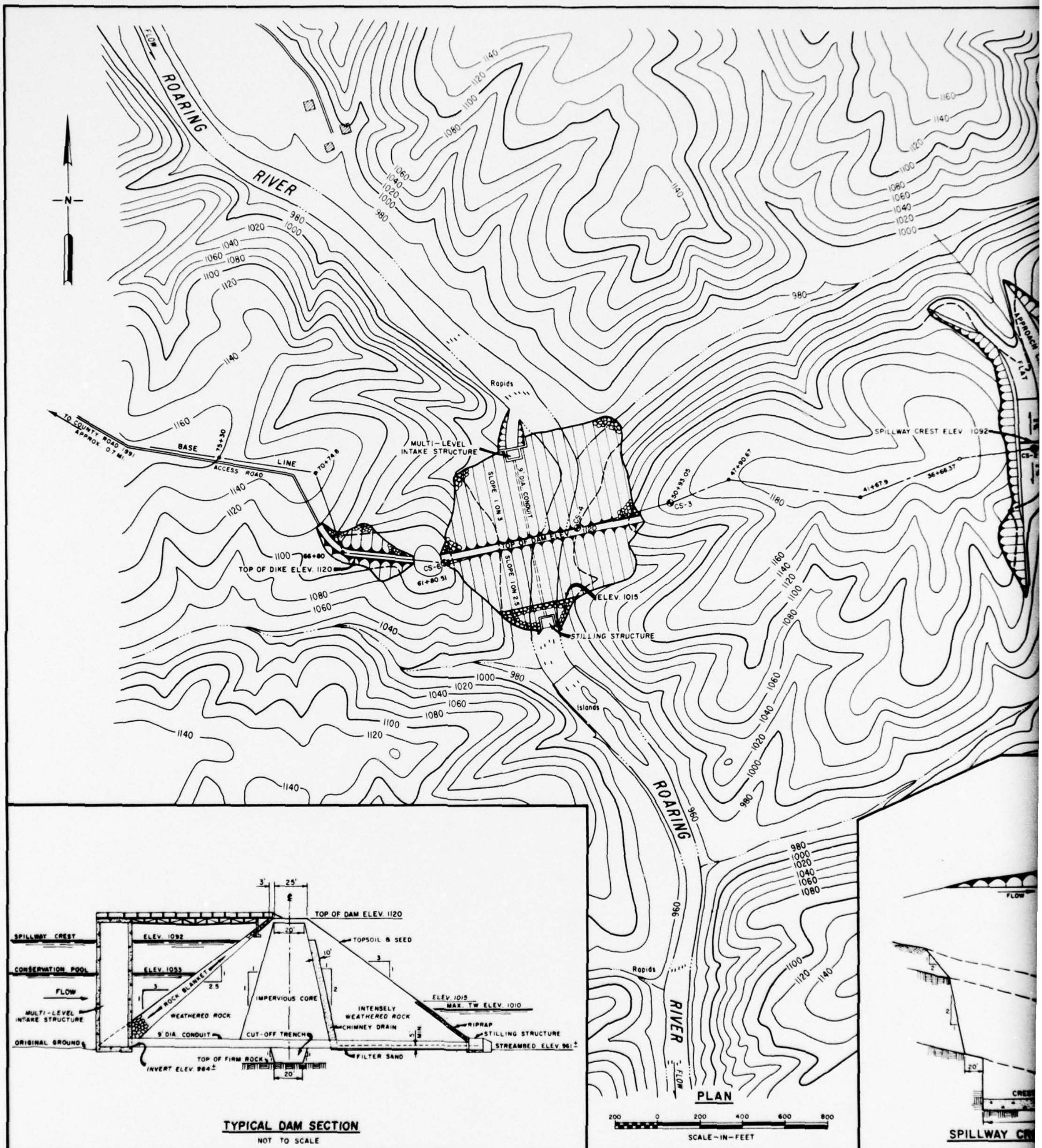

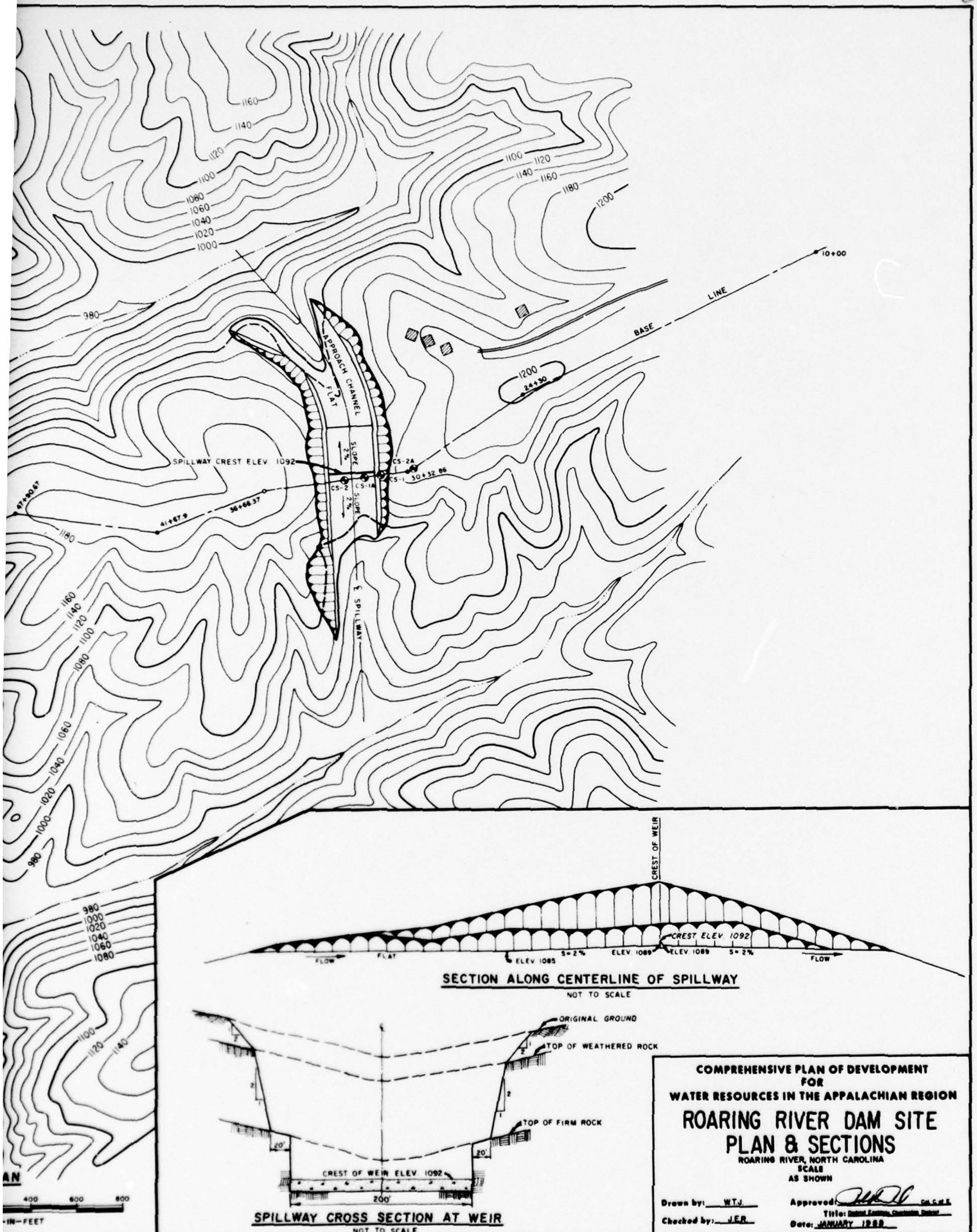

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROARING RIVER DAM SITE
PLAN & SECTIONS

ROARING RIVER, NORTH CAROLINA
SCALE
AS SHOWN

Drawn by: W.T.J.
Checked by: J.E.R.

Approved: Col. C of E.
Title: District Engineer, Charleston District
Date: JANUARY 1968

EXHIBIT 6-11

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The outlet works would consist of an intake tower, a 9-foot cut and cover conduit and a stilling basin located on the left bank. The tower would be equipped with two 4 x 9 foot service gates, one emergency gate of the same size, and additional intake gates at various levels to permit selective temperature and/or oxygen content control of releases. A stilling basin sized to accommodate the discharges from the main gates will be provided at the downstream toe of the dam. Access to the control tower would be by a bridge from the crest of the dam.

Construction would take 2 years. The conduit together with the control tower would be built first and used for diversion. Construction of the main dam and excavation of the spillway would be concurrent to permit placing of the excavated materials in the embankment without rehandling. Main coffer dams would be incorporated into the permanent structure. Additional materials for the fill will be excavated from borrow areas. Residual soils of an impervious type suitable for rolled earth construction occur in great abundance in the areas adjacent to the site.

Concrete and road materials are available within reasonable trucking distance.

Qualified construction labor should be available within a reasonably close proximity of the project. Employment in the construction sector was 6,661 persons in 1960, a gain of 1,029 over 1950 for the five-county state planning sub-region in which the project is located. While unemployment rates have been declining (a typical phenomenon in the nation during recent years), some of the unemployed have had experience in the cyclically sensitive construction industry.

13. RELOCATIONS

There are no existing railroads within the limits of the proposed Roaring River Reservoir, which is shown on exhibit 6-3.

The project is traversed by several county roads, although no state or U.S. Routes cross the proposed project. About 1.5 miles of county roads will be raised or relocated to maintain an effective transportation system, near and across the proposed project.

There are no known utilities within the proposed reservoir area.

14. REAL ESTATE

Acquisition of lands and improvements will be required to permit the construction and operation of the reservoir, for specific, general and fish and wildlife recreation access and use and to mitigate project occasioned losses to wildlife habitat.

The tentative guide taking line for Roaring River Reservoir has been established at elevation 1097 or 300 feet horizontally from elevation 1092, whichever encompasses the greater land area. Cost estimates for the project are based on the criteria of 300 feet horizontally from elevation 1092 which is believed to be the controlling area. Total land area required for the project is 4,780 acres, which includes 300 acres of recreation areas situated above the guide taking line and 200 acres of land for wildlife mitigation purposes, located adjacent to the Thurmond Chatham Wildlife Management Area. All land is proposed to be acquired in fee simple.

Improvements includes 24 residences, no commercial establishments, and one church with adjacent cemetary. About 24 families will be displaced by the proposed project. Acquisition of project land and the relatively small number of persons thus displaced should not affect real estate prices to the point of inflating asking prices for replacement homes. Although some speculative activity is anticipated because of enhanced land use, through development of land adjacent to the reservoir for recreation and vacational uses, somewhat higher prices for this land can be anticipated.

The Bureau of Mines, Department of Interior, reports no significant mineral values or workings in the project area.

15. RECREATION - THE CONCEPT EVOLUTION

The Roaring River Reservoir site lays in the eastern slopes of the Blue Ridge Mountains in northwestern North Carolina which is characterized by narrow valleys and steep ridges. The stream sustains a cold water fishery including rainbow trout in the upper reaches and low to moderate populations of small mouth bass, rock bass, bluegill, catfish and suckers in the lower reaches. Unfavorable topography coupled with rather limited access has resulted in relatively low density uses by man, and relatively high quality water and scenic resources are typical. The immediate reservoir and downstream areas consist largely of woodlands and occasional interspersion of open farm and pasture lands.

Development of public access and public use facilities for general and fish and wildlife recreation enhancement will be made in a manner which will preserve the pastoral and wooded setting of the reservoir. Good zoning practices between potential conflicting uses will be followed to maximize user satisfaction in a manner which is consistent with good design and safety practices. A preliminary layout of recreation areas or developed by BOR is shown on exhibit 6-12.

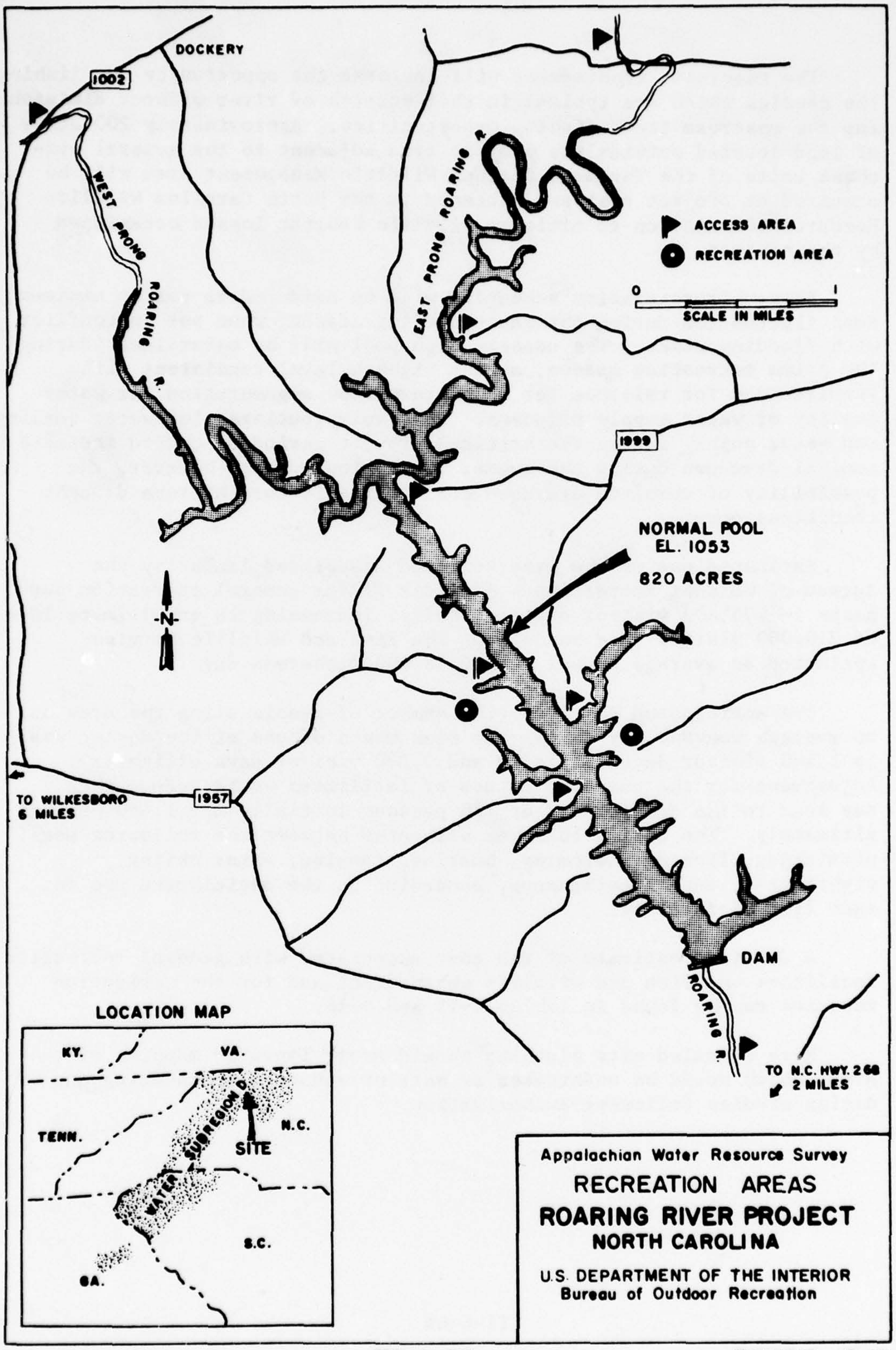

DOCKERY
1002
WEST PRONG ROARING R.
EAST PRONG ROARING R.
ACCESS AREA
RECREATION AREA
0
1
SCALE IN MILES
1999
NORMAL POOL
EL. 1053
820 ACRES
N
TO WILKESBORO
6 MILES
1957
DAM
ROARING R.
TO N.C. HWY. 268
2 MILES
LOCATION MAP
KY.
VA.
TENN.
N.C.
SITE
WATER SUBREGION D
S.C.
GA.
Appalachian Water Resource Survey
RECREATION AREAS
ROARING RIVER PROJECT
NORTH CAROLINA
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Outdoor Recreation

EXHIBIT 6-12

The reservoir impoundment will increase the opportunity for fishing the species which are typical in that stretch of river without diminishing the upstream trout fishing opportunities. Approximately 200 acres of land located outside the project area adjacent to the general purchase units of the Thurmond Chatham Wildlife Management Area will be acquired at project cost and licensed to the North Carolina Wildlife Resources Commission to mitigate wildlife habitat losses occasioned by the project.

Reservoir regulation schedules will be arranged to permit minimum pool fluctuation during the bass-spawning season, when not in conflict with flooding risks. The conservation pool will be maintained, during the prime recreation season, at the highest level consistent with requirements for releases for downstream flow augmentation for water quality or water supply purposes. Reservoir routings, for water quality and water supply during the critical drought period of record indicate nominal drawdown during the summer recreation months; however, the possibility of complete drawdown would exist if more extreme drought conditions occur.

Estimated use of the reservoir and associated lands (by the Bureau of Outdoor Recreation - Appendix F) for general recreation purposes is 105,000 visitor days initially, increasing to an ultimate level of 210,000 visitor days annually. The Fish and Wildlife Service estimated an average annual use of 16,000 fisherman days.

The anticipated day load (the number of people using the area on an average weekend day during the peak month of use of the design year) is 1,440 visitor days initially and 2,880 visitor days ultimately. Adjustment for the turnover in use of facilities would reduce the day load to the design load of 720 persons initially and 1,440 persons ultimately. The design load was allocated between the following uses: picnicking, fishing, swimming, boating, camping, water skiing, sightseeing, and miscellaneous, according to the anticipated use for each kind of facility.

A detailed estimate of the cost associated with general recreation facilities and fish and wildlife enhancement and for the mitigation measures can be found in tables 6-15 and 6-16.

More detailed site planning should await improved mapping of the area, which would be undertaken as part of advanced engineering and design studies following authorization.

TABLE 6-15

Detailed Estimate of General Recreation
Fish and Wildlife Recreation and
Wildlife Mitigation Costs

ROARING RIVER RESERVOIR, NORTH CAROLINA

ITEM	UNIT	UNIT COST	Initial Quantity	Initial Amount	Future Quantity	Future Amount	Total Quantity	Total Amount
FACILITIES - General Recreation and Fish and Wildlife Recreation								
Picnic Units	Each	$ 2,500	9	$23,000	9	$23,000	18	$46,000
Picnic Shelters	Each	12,000	1	12,000	1	12,000	2	24,000
Camping Units	Each	1,700	15	26,000	18	31,000	33	57,000
Parking Spaces	Each	340	59	20,000	43	15,000	102	35,000
Roads	Mile	30,000	3	90,000	4	120,000	7	210,000
Boating Unit	Each	40,000	1	40,000	1	40,000	2	80,000
Water Supply	Each	1,300	10	13,000	10	13,000	20	26,000
Sanitation	Each	10,000	3	30,000	3	30,000	6	60,000
Swimming Beach	S.F.	1.35	6,500	9,000	7,900	11,000	14,400	20,000
Trails	Mile	8,000	3	24,000	3	24,000	6	48,000
Site Improvement	Job	--	Job	2,000	Job	2,000	--	4,000
SUBTOTAL - FACILITIES				$289,000		$321,000		$610,000
Contingencies (20%)				59,000		64,000		122,000
Engineering & Design and Supervision & Administration				37,000		43,000		81,000
Total Cost General Recreation and Fish & Wildlife Facilities				385,000		428,000		813,000
FACILITIES - Wildlife Mitigation								
Habitat Improvement (Non-Federal Cost)	Job			1,000		--		1,000
REAL ESTATE - General Recreation								
Land	Acres	200	300	60,000			300	60,000
Acquisition Costs	Job			17,000				17,000
Total Cost Real Estate - General Recreation				$77,000				$77,000
REAL ESTATE - Wildlife Mitigation								
Land	Acres	--	200*/	23,000				23,000
Total Cost General Recreation and Fish & Wildlife Recreation Land & Facilities				$486,000		$428,000		$914,000

*/ Estimated cost, including Acquisition = $23,000.

TABLE 6-16

Detailed Summary of Annual Costs and Benefits
for Recreation

ROARING RIVER RESERVOIR, NORTH CAROLINA

	Initial Increment	Future Increment	Total	Future Increment Discounted	Total With Future Increment Discounted
CONSTRUCTION COSTS: $1,000					
Facilities - Gen. Rec. & WL	385	428	813		
Real Estate - Gen. Rec.	77	--	77		
Total Construction Costs	462	428	890		
INVESTMENT COSTS: $1,000					
General Recreation and Fish & Wildlife Construction	385	428	813		
Interest During Construction (2 yrs)	13	--	13		
Real Estate - Gen. Rec.	77	--	77		
Interest During Construction (2 yrs)	3	--	3		
Total Investment General and Fish & Wildlife Recreation Lands and Facilities	478	428	906		
ANNUAL CHARGES: Specific-Use Lands & Facilities $1,000					
Interest on Investment1/	16			8	24
Amortization of Investment1/	1			-	1
Major Replacement2/	3			2	5
Direct Operation & Maintenance3/	23			12	35
Loss in Land Productivity4/	1				1
Total, Annual Economic Charges	44				66
Total, Annual Financial Charges	43				65
VISITATION: (1,000)					
General Recreation	105	105	210		
Fishing (Pool)	16	0	16		
Hunting	0	0	0		
Total, Visitation	121	105	226		
BENEFITS: $1,000					
General Recreation	131	131	262		202
Fishing (Pool)5/	15	0	15		15
Hunting	0	0	0		0
Total Benefits	146	131	277		217

1/ Interest project life 100 years 3.25%, Amortization .00138 and discount factor .5401
2/ Major Replacement - Initial Facility Investment x 1/3 x .0252
Future Increment Facility Investment x 1/3 x .0133
3/ Operation and Maintenance $.20 per visitor day, future increment discounted by .5418
4/ Loss in Land Production ([5.00 - 3.25] x 77)
5/ Net fishing benefit with the project.

SECTION IV - COST ESTIMATES

16. PROJECT COSTS

The total cost of construction of the Roaring River Reservoir is estimated to be $10,758,000. Estimates of first cost for the dam and reservoir include cost of initial construction, future recreation facilities, contingencies, engineering and design and supervision and administration. Construction costs were based on the detailed layouts shown in exhibit 6-11 and design considerations discussed in paragraph 11. Unit prices for the cost estimate are based on prices for similar work in nearby areas and are adjusted to December 1967 price levels. Allowances for contingencies reflect the level of uncertainty accompanying cost estimates developed after normal survey investigation procedures. Detailed cost estimates are shown in tables 6-17 and 6-18.

Total investment costs and annual financial charges were developed for the Roaring River Reservoir and associated developmental plan (see table 6-19). Investment costs include construction costs plus interest accrued during the construction period (3-1/4 percent interest in 2 year construction period). Annual charges were computed at the 3-1/4 percent interest rate and 100-year amortization period. Operation and maintenance costs were based on current costs for similar projects. An allowance for major replacement is included to permit the replacement of the operating equipment.

17. DEVELOPMENTAL COSTS

Several kinds of developmental benefits were expected to result from the construction of the Roaring River Reservoir. Each kind of development entailed certain costs which are associated with attainment of these benefits. These costs include investments undertaken by public and private enterprise and the cost of staffing operation and maintenance and replacement required to continue these activities.

One of the most important developmental effects would be the impact at Elkin-Jonesville from the additional flood plain lands provided a high degree of flood protection. The incremental effect of Roaring River Reservoir, in addition to W. Kerr Scott and Reddies River Reservoirs, would be to reduce the 100-year flood event to an elevation of about 691 at the Highway 21 bridge. The reduction in flooding hazard would enable the firms already located within the flood plain to expand their operations and exploit further their locational advantages to markets and to the favorable labor supply. New firms can also locate in the same area, to supply additional inputs for existing firms which are expanding and to utilize the output of existing firms in the

TABLE 6-17

SUMMARY OF CAPITAL COST

ROARING RIVER RESERVOIR, N. C.
(December 1967 prices)

No.	Item	Cost
1.	Lands and damages	$1,121,000
2.	Relocations	356,400
3.	Reservoir	146,400
4.	Dam and appurtenances	7,070,200
5.	Recreation facilities	733,000
6.	Permanent operating equipment	120,000
7.	Buildings, grounds, & utilities	120,000
8.	Engineering and design	387,000
9.	Supervision & administration	704,000
	TOTAL PROJECT COST	$10,758,000

SUMMARY OF ANNUAL COST

ROARING RIVER RESERVOIR, N. C.

1.	Interest on gross investment	355,000
2.	Amortization of gross investment	15,000
3.	Maintenance and operation	79,200
4.	Major replacements	20,000
	TOTAL	$ 469,200

TABLE 6-18

DETAILED ESTIMATE OF FIRST COSTS

ROARING RIVER MULTIPLE PURPOSE RESERVOIR PROJECT
(December 1967 prices)

Item	Unit	Quantity	Unit Price	Amount
I. LANDS AND DAMAGES				
Land	Acre	4,780	137.00	653,900
Improvements				172,000
Severance				57,300
Resettlement				17,500
Acquisition				33,500
Contingencies (20%)				186,800
TOTAL, LANDS & DAMAGES				$1,121,000
II. RELOCATIONS				
Roads (county)	Mile	1.5		86,500
Bridge	Each	1		200,000
Demolition	L.S.			10,000
Contingency (20%)				59,300
TOTAL, RELOCATIONS				$ 356,400
III. RESERVOIR				
Clearing & grubbing	Acre	330	350.00	115,500
Clearing	Acre	100	60.00	6,000
Contingency (20%)				24,900
TOTAL, RESERVOIR				$ 146,400
IV. DAM AND APPURTENANCES				
Dam and spillway				
Clearing & grubbing construction & work areas	Acre	50	400.00	20,000
Stripping	C.Y.	25,800	0.60	15,480
Access Road & Railroad	L.S.	1		350,000
Field Office	L.S.	1		20,000
Stream Diversion & Care	L.S.	1		180,000
Excavation, spillway common	C.Y.	123,000	0.50	61,500
Excavation, spillway rock	C.Y.	200,000	2.25	450,000

Item	Unit	Quantity	Unit Price	Amount
Excavation, earth, borrow	C.Y.	1,464,000	0.65	951,600
Fill (rolled)	C.Y.	1,531,000	0.10	153,100
Upstream rock blanket & downstream riprap	C.Y.	183,500	6.00	1,101,000
Topsoil & seeding	Acre	20	1,300.00	26,000
Grouting & foundation preparation	L.S.	1		200,000
Concrete weir (mass)	C.Y.	200	35.00	7,000
Concrete (reinforced)	C.Y.	75	40.00	3,000
Cut-off trench	C.Y.	15,000	1.50	22,500
Bank & channel protection	L.S.	1		850,000
Stone gutters	L.S.	1		30,000
Dike	L.S.			139,200
Contingency (20%)				916,100
TOTAL, DAM AND SPILLWAY				5,496,500
Outlet Works				
Excavation, unclassified	C.Y.	8,000	2.00	16,000
Concrete - conduits	C.Y.	2,000	60.00	120,000
Entrance & exit walls & riprap	L.S.			20,000
Stilling basin	L.S.			30,400
Gatehouse, gates, machinery, multi-level features, complete	L.S.			1,125,000
Contingencies				262,300
Total, Outlet Works				$1,573,700
TOTAL, DAM AND APPURTENANCES				$7,070,200
V. RECREATION FACILITIES				
Initial development				
Facilities cost	L.S.			289,000
Contingencies				59,000
Total, Initial Development				$ 348,000
Future development				
Facilities cost				321,000
Contingencies				64,000
Total, Future Development				$ 385,000

Item	Unit	Quantity	Unit Price	Amount
VI. PERMANENT OPERATING EQUIPMENT				
Precipitation stations	Ea.	1	1,200	$ 1.2
Office equipment	L.S.			2.0
Shop equipment	L.S.			8.0
Diesel-electric generator	Ea.	1		10.0
Instrumentation, stream stage & water quality	L.S.			15.0
Radio communication facilities	L.S.			3.0
Streamgaging stations	Ea.	2	3,500	7.0
Transportation, reservoir & grounds maint. equip.	L.S.			35.0
Floating plant	L.S.			15.0
Sediment ranges	L.S.			3.8
Sub-total				$ 100
Contingencies (20%)				20
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 120
VII. BUILDINGS, GROUNDS, AND UTILITIES				
Three bedroom residences	Ea.	2	20,000	40,000
Sitework, clearing & grading	L.S.			20,000
Utilities	L.S.			10,000
Maintenance Buildings	L.S.			30,000
Contingencies (20%)				20,000
TOTAL, BUILDINGS, GROUNDS, & UTILITIES				$ 120,000
VIII. ENGINEERING AND DESIGN				
Initial development	L.S.			371,300
Future increment	L.S.			15,700
TOTAL, ENGINEERING AND DESIGN				$ 387,000
IX. SUPERVISION AND ADMINISTRATION				
Initial development				675,700
Future increment				28,300
TOTAL, SUPERVISION AND ADMINISTRATION				$ 704,000
TOTAL PROJECT COST:				$10,758,000

TABLE 6-19

DETAILED ESTIMATE OF FINANCIAL ANNUAL COST

ROARING RIVER RESERVOIR, N.C.

Item	
Total Investment	
(1) Recapitulation of project costs	
(a) Initial costs	$ 10,329,000
(b) Incremental costs	429,000
(2) Interest during construction (initial costs only) at 3-1/4% for 1/2 of construction period of 2 years	336,000
(3) Total Gross Investment	$ 11,094,000
Annual Initial Costs	
(1) Interest on gross initial investment (10,195,000) (3-1/4%)	347,000
(2) Amortization (10,195,000) (.00138)	15,000
(3) Maintenance and operation	
(a) Dam and reservoir	44,000
(b) Recreation	23,200
(4) Major replacements	
(a) Dam and reservoir	15,000
(b) Recreation	3,000
(5) Total initial annual costs	$ 447,000
Annual Future Incremental Costs	22,000
Total annual costs	$ 469,200

chain of transactions leading to final consumption. Construction of Interstate 77 will enhance the locational advantages of Elkin-Jonesville and create a new demand for commercial development near the interchange.

Approximately 220 acres of land within the urban limits of Elkin-Jonesville will be provided a high degree of protection given the addition of Roaring River Reservoir to W. Kerr Scott and Reddies River Reservoirs. Of this area, 114 acres would have favorable topography and size to permit efficient urban development. The net increment of the 114 acres attributable to Roaring River Reservoir would be 30 acres.

Approximately 53 acres should be prime commercial sites and about 50 acres should be useful for industrial sites with rail and road access, while the remaining 10.7 acres would be used for residential development. Thus, site improvement costs in these land uses and the cost of commercial and industrial buildings and facilities and residential property are relevant developmental costs.

The water supply storage included in Roaring River Reservoir will provide about 16 mgd additional dependable yield to downstream users. A deficit in water supply would constrain development of the Winston-Salem growth center after the year 2000. The increment of employment and population which could be supported by the additional water supply is 8,000 and 30,000, respectively. The average investment per employee is considered to be the relevant developmental cost.

The recreational use of the reservoir and facilities will have an impact on incomes for the region. If we assume that the expenditures of recreation visitors would otherwise be saved the total expenditure and the employment stream thereby created would be a gain. Assuming all the expenditures are transfers or would be spent on substitutes would result in no net gain.

On the other hand, BOR estimates of origin of visitation in Appendix F indicate that 10 percent would be from distances in excess of 76 miles. This increment of visitation is considered to be from outside of Appalachia and their expenditures a net increment of income to Appalachia. Thus, the investment costs required to satisfy this expenditure stream is considered to be the relevant cost of income expansion.

A summary of the estimated costs associated with the development anticipated to follow from construction of the Roaring River Reservoir is presented in table 6-20.

TABLE 6-20

DEVELOPMENTAL COSTS ASSOCIATED WITH
ROARING RIVER RESERVOIR, N.C. ($1,000)

Item	Investment Costs		Annual Charge
Elkin-Jonesville			
Industrial	2,930		
Commercial	2,126		
Residential	50	5,106	136
Winston-Salem		88,000	1,022
Recreation Industry		320	10
Total		93,426	1,168

SECTION V - BENEFITS

18. SUMMARY

The reservoir and developmental investment anticipated to follow the construction of the reservoir would provide benefits to users of project goods and services to the nation and to the Appalachian Region from the subsequent income expansion. User benefits may accrue to the nation only if users are located outside of the Appalachian Region. Following paragraphs of this section describe the procedures and assumptions used to measure the various classes and kinds of benefits. Table 6-21 summarizes these benefits by category and according to the national and/or regional account.

TABLE 6-21

SUMMARY OF BENEFITS
ROARING RIVER RESERVOIR, NORTH CAROLINA

Item	Annual Benefits ($1,000)				
	National Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefits					
Flood Control	12	-	135	147	135
Water Supply	-	-	50	50	50
Water Quality Control	42	-	125	167	125
Recreation	19		198	217	198
Total	73	-	508	581	508
Expansion Benefits					
Redevelopment	-	78	39	39	117
Developmental	-	990	6,639	6,639	7,629
Total	-	1,068	6,678	6,678	7,846

19. USER BENEFITS

Benefits to users would accrue from the flood control, water quality control, water supply and recreation features of the project. For all practical purposes, all users, except a small number of recreation users, are located within the Appalachian Region. User benefits are estimated by various methods to approximate the value that users would be willing to pay for the goods and services provided by the project.

Flood Control

The reduction in flooding damages to current and anticipated future development along the Yadkin River is considered a user benefit from the provision of flood control storage space and reservoir operation procedures. Damages prevented to future development is exclusive of project-induced development and assumes that development of the flood plain will continue to be based on the same precision and completeness of information that has been historically available. Thus, we assume neither highly restrictive flood plain management and zoning practicies, nor deliberately stimulated flood plain development.

The anticipated increase in land values associated with improved land use capability is included in flood control benefits as enhancement. The gains do not include damages prevented under the enhanced land use.

Damages prevented by the Roaring River Reservoir are those residuals remaining after the effects of W. Kerr Scott and Reddies River Reservoirs are deducted from the damages expected under natural conditions.

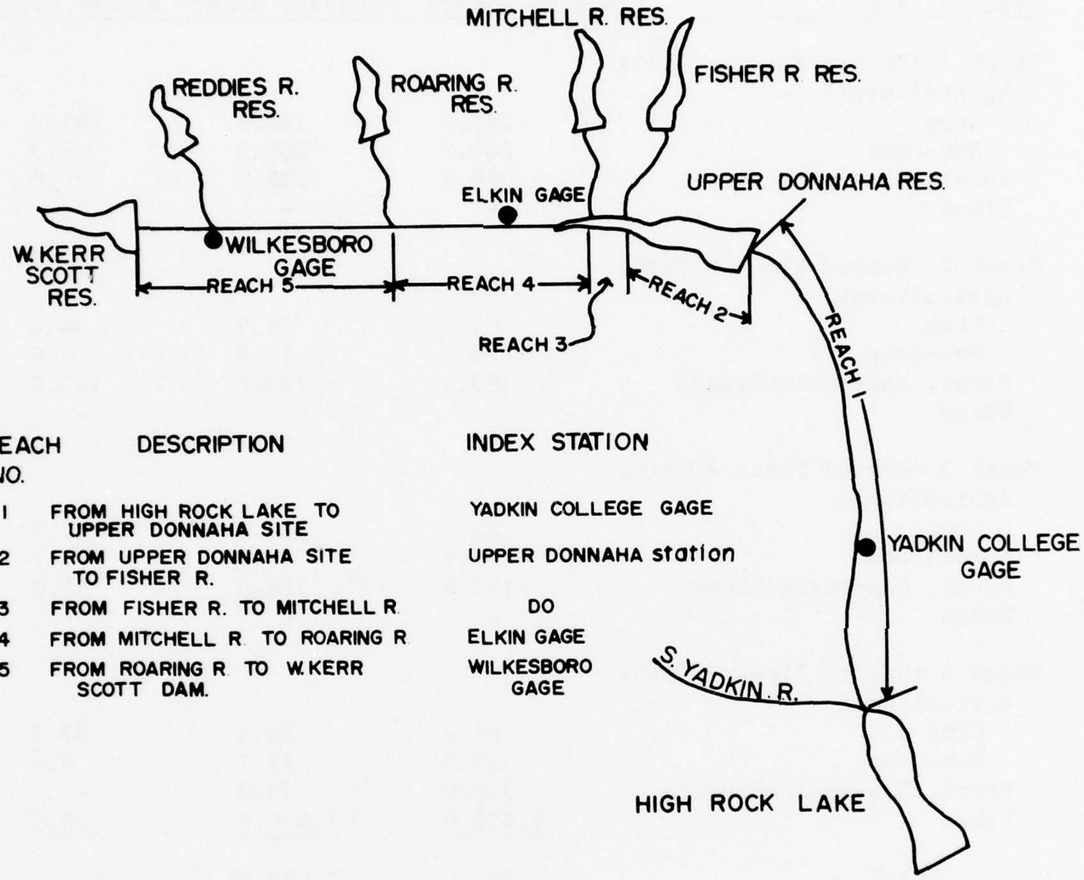
Extent and Character of the Flooded Area

The flood plain area, downstream from the Roaring River Reservoir, contains two urban developments (Elkin and Jonesville), about 9,000 acres of agricultural land, and various transportation routes. The major transportation route included in the flood plain is the Southern Railroad.

Flood Damages

Data used to develop flood damage estimates for different levels of flooding were based on new and previous surveys brought up to date to represent current damages and development. For study purposes, the overflow area was divided into five flood zones as shown in exhibit 6-13. Flood heights in the four downstream zones are affected by W. Kerr Scott, Reddies and Roaring River Reservoirs, with progressively diminishing effects in downstream zones to High Rock Lake.

Based on these damage data, the damage caused by recurrence of the 1940 flood and for floods having a theoretical recurrence intervals of 20 and five years is estimated to be $7,865,000, $2,609,900, and $1,003,200 respectively. A detailed breakdown of estimated damages by category for the portion of the Yadkin River affected by Roaring River Reservoir is given in table 6-22.



REACH NO.	DESCRIPTION	INDEX STATION
1	FROM HIGH ROCK LAKE TO UPPER DONNAHA SITE	YADKIN COLLEGE GAGE
2	FROM UPPER DONNAHA SITE TO FISHER R.	UPPER DONNAHA station
3	FROM FISHER R. TO MITCHELL R.	DO
4	FROM MITCHELL R. TO ROARING R.	ELKIN GAGE
5	FROM ROARING R. TO W. KERR SCOTT DAM.	WILKESBORO GAGE

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

FLOOD DAMAGE REACHES & INDEX STATIONS UPPER YADKIN RIVER, NORTH CAROLINA

Drawn by: ________ Approved: ________
Checked by: ________ Title: ________
Date: ________

EXHIBIT 6-13

TABLE 6-22

DAMAGE FOR RECURRENCE OF SPECIFIC FLOODS
UPPER YADKIN RIVER, N.C.

Reach & Item	Damages for Flood Recurrence ($1,000) 1/ Flood of Record	20-year Event	5-year Event
Reach 1 (Record Flood = 1916)			
Agricultural			
Crop	242.9	196.6	167.2
Non-crop	200.6	108.5	46.3
Rural, Non-agricultural	1,320.0	735.0	470.0
Urban	-	-	-
Reach 2 (Record Flood = 1916)			
Agricultural			
Crop	44.0	39.9	38.4
Non-crop	26.1	11.8	6.0
Rural, Non-agricultural	393.0	225.0	143.0
Urban	-	-	-
Reach 3 (Record Flood = 1916)			
Agricultural			
Crop	21.7	19.1	17.9
Non-crop	13.2	7.8	3.7
Rural, Non-agricultural	195.0	118.0	52.0
Urban	-	-	-
Reach 4 (Record Flood = 1940)			
Agricultural			
Crop	64.2	50.5	30.3
Non-crop	52.3	27.7	8.4
Rural, Non-agricultural	242.0	70.0	-
Urban	5,050.0	1,000.0	20.0
Total	7,865.0	2,609.9	1,003.2

1/ 1967 Values and Conditions.

Residential Damages

Flooding damages to residential property were estimated by establishing first floor elevations and points of zero damage by survey. A sampling procedure was adopted to estimate damages to furnishings and other tangible losses. Market values were established by reference to assessed evaluation and to real estate transactions for similar property within the area. Physical damages for various elevations of flooding were then estimated with the aid of flood damage tables constructed for this purpose.

Commercial Damages

Flood damages to commercial establishments were established by means very similar to those utilized for residential damages, except a higher percentage of establishments were interviewed. Damages include physical loss to buildings, fixtures and stock and business losses due to interruption in business, cleanup costs and any other extraordinary costs associated with flooding. If payrolls were maintained during the flood interruption, the costs would be counted as a loss in income.

Industrial Damages

Every industrial firm was interviewed to determine losses from various degrees of flooding, and a positive response was elicited from most firms. Losses include physical damages to plants, equipment, stock and inventories. Reduced profits for extraordinary costs attributable to flooding were included as damages.

Utility Damages

Utility damages were determined by methods very similar to those utilized for estimating industrial damages. Utility damages include flood damages to sewers, gas, water plants, electrical power facilities and telephone facilities.

Transportation Damage

Flood damages to transportation facilities were estimated from interviews with state and local road officials and by interviews and letter with Southern Railroad. Previous survey data were also updated to reflect recent price and design changes.

Crop Damage

Flood damages to crops were estimated by determining land use and then estimating losses to each crop, accounting for seasonality, depth and duration of inundation for various flood events. A composite damage value was developed which weights the effects of time of occurrence, duration and depth of flooding on various crops typical for the flood plain.

Non-Crop Damage

Floods cause damages to agricultural lands in addition to crop losses. Flood plain scour, erosion and sterile sediment deposition result in losses in income as do damages to fences, farm roads and other farm improvements.

Damage Curves

Stage damage curves were constructed for each damage zone by aggregating losses to residential, commercial, industrial, transportation routes and crop and non-crop agricultural losses over a range of flood stages. Damages were related to elevation of the stream gage considered typical of stages in the damage zone.

Intangible Damages

Flooding causes damages to health and life which are not adequately measured by monetary terms. The 1940 flood was reported in Winston-Salem papers to have resulted in one dead, 500 people homeless, and 2,500 persons without jobs. Wilkesboro, North Wilkesboro and Elkin were reported to be isolated from all communities within the area, and to be without drinking water or fire-fighting facilities during the flood.

Future Growth

The damages prevented for development of the flood plain in the future are credited as benefits to the project, when limited to the degree of development which could be anticipated in the absence of Roaring River Reservoir. A significant measurement problem occurred in this estimate since we assume the operation of W. Kerr Scott and Reddies River Reservoirs. Normal developmental trends are based on the expected level of flood risk information available to industries in flood plain development.

Agricultural damages are expected to increase with projected increases in real agricultural output. Urban damages are expected to increase proportionately with projected increases in urban population and to increase as higher incomes permit increased acquisition of improved household appliances and furnishings. The agricultural output projections of USDA (published in table XVII - Appendix A) indicate an increase in output in Water Sub-region D from $150,324,000 in 1964 to $256,126,000 in 2020, an increase of 1.71 from 1964 to 2020. Since the estimates are in terms of constant (1957-1959) dollars the ratio of 1.7 representing 56-year period can be extrapolated to 1.7/56 x 100 = 3.03 to reflect the 100-year project economic life. Thus, 1967 agricultural damages should be increased by 3.03 times to reflect 2067 damages and the increment discounted by compound interest methods to convert to an average annual equivalent value. A factor of .569 (2.03 x .28) times 1967 annual damages would represent the future increment of damages.

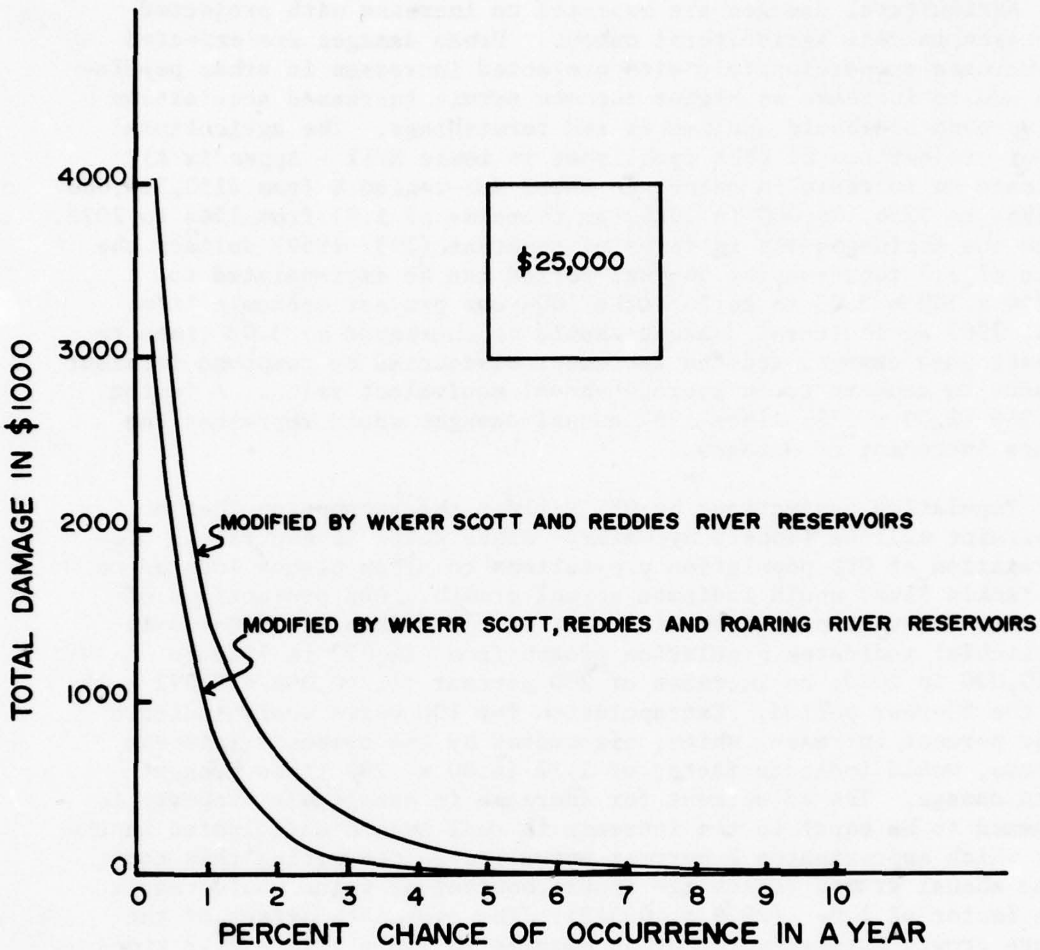
Population projections by OBE reflect the assumption that no constraint will be imposed by water. Since water is neutral, a disaggregation of OBE population projections to urban places located on the Yadkin River would indicate normal growth. OBE projections of Economic Sub-region 15 (contains most of the Yadkin River Basin in Appalachia) indicates population growth from 418,072 in 1960 to 1,240,000 in 2020, an increase of 200 percent (1,240,000/418,072 - 1) for the 50-year period. Extrapolation for 100 years would indicate a 400 percent increase, which, discounted by the compound interest methods, would indicate factor of 1.12 (4.00 x .28) times present urban damage. The adjustment for increase in damageable property is assummed to be equal to the increase in real income anticipated in the U.S. which approximates 2 percent annually.*/ Converting this compound annual growth to average annual equivalent value would result in a factor of 1.0. (29.9 x .03388). The aggregate effect of the future growth estimates for urban damages is 1.0 + 1.12 = 2.12 times current urban damage.

Average Annual Benefits

Flood damages, by stage, were converted to average annual values by multiplying the frequency of occurrence for each stage times the damage of the stage to weight damage by probability. The difference in average annual damages with and without Roaring River Reservoir added to the system is credited as a benefit to the project.

A graphic integration of stage damage and stage frequency is presented in exhibit 6-14 for Elkin damage zone. The area under the curve represents average annual damages and benefits to current

*/ Upper Licking River Survey Report, Appendix A.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

DAMAGE FREQUENCY CURVE YADKIN RIVER- DAMAGE REACH 4 ELKIN INDEX STATION

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Checked by:________ Date:________

EXHIBIT 6-14

development. The benefits were adjusted to reflect normal future growth as outlined in the preceding paragraph.

Enhancement Benefits

Reduced flooding hazards permit land uses to change to higher, more productive uses for both agricultural and urban situations. The changes in productive capability are capitalized in increased land values. This gain is distinct from damages prevented to current land uses and incremental to future growth. Enhancement benefits are deliberately sought for greater economic return from use of the land. Enhancement benefits attributed to Roaring Reservoir accrue to about 3,150 acres of cropland, yielding an anticipated increased annual earning of about $6.00 per acre, resulting in annual enhancement benefits amounting to about $18,900. Roaring River Reservoir provides 100-year protection to over 1,100 acres in the four damage zones and would provide a lower degree of protection to a much larger area.

Table 6-23 presents a summary of flood control benefits by damage zones for the Roaring River Reservoir.

TABLE 6-23

SUMMARY OF AVERAGE ANNUAL FLOOD CONTROL BENEFITS ($)
ROARING RIVER RESERVOIR, N.C.

Stream/Reach	Damages Prevented to Current Development		Damages Prevented to Future Development		Total Flood Control Benefits
	Urban	Rural	Urban	Rural	
Yadkin River					
4	16,800	7,500	35,600	4,300	64,200
3		5,200		3,000	8,200
2		8,400		4,800	13,200
1		27,500		15,600	43,100
Total	16,800	48,600	35,600	27,700	128,700
Enhancement					18,900
Total					147,600
				(rounded)	147,000

Recreation Benefits (General)

An analysis of the general recreation potential of the Roaring River Reservoir was made by the Bureau of Outdoor Recreation (see Appendix F). Ultimate attendance is estimated to be 210,000 recreation days annually with initial attendance at one-half this level. The benefits value per recreation day is estimated to be \$1.25. Drawdown on the recreation pool is not expected to create serious conflicts with recreational use of the reservoir, since the maximum drawdown during the record drought period would have occurred in February. Annual benefits for the general recreation use of the reservoir is estimated to be \$202,000 (210,000 x \$1.25 times 0.7685*).

Fish and Wildlife

The Fish and Wildlife Service evaluated the potential for fish and wildlife enhancement of the Roaring River Reservoir (see Appendix G). The net increase in fishermen days is estimated to be 15,000 annually with a unit value of \$1.00 per day, resulting in annual benefits of \$15,000. Losses in hunting opportunities would be mitigated by the acquisition of 200 additional acres to add to the Thurmond Chatham Wildlife Management Area at project cost. This unit would be licensed to the State of North Carolina and managed by the State.

Water Quality Control

The Federal Water Pollution Control Administration has evaluated the need for and value of providing storage for the augmentation of low flows in the Yadkin River. The critical reach of the river would be downstream from Muddy Creek, a tributary which receives the treated waste from Winston-Salem. The flow objective outlined previously in Section III and in Appendix D would require about 35,000 acre-feet of storage above the critical reach. A single-purpose structure at the Roaring River site is considered to be the most economical source of dilution water. The cost of the most efficient single-purpose alternative is considered to be the benefits of water quality control measures. Based on 3-1/4 percent interest rate, and 100-year amortization schedule, the annual charges for the alternative project would be \$321,000. Plan formulation studies indicate that about 18,000 acre-feet of the total requirement of 35,000 acre-feet should be placed in the multiple purpose Roaring River Reservoir. Thus, the fraction 18/35 of the total benefits or \$167,000 are credited as benefits to Roaring River Reservoir.

Water Supply

The value of water supply storage placed in Roaring River Reservoir is related to "willingness to pay" by seeking the cost of the most

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* Correction factor for accelerated growth curve.

efficient alternative source of dependable water supply. Five thousand one hundred sixty acre-feet of storage would be allocated to water supply in Roaring River Reservoir with an estimated dependable net yield of 16 mgd and gross yield of 34 mgd based on the period of record. An alternative single-purpose project at the multiple-purpose site would cost on the order of $6,000,000. The range of costs for smaller structures, typical of SCS watershed projects were examined as relevant alternative costs. The Hunting Bear Creek Watershed (a tributary of the South Yadkin River) was evaluated by SCS for water supply and quality uses. At a 10 percent chance of shortage the yield from 73,530 acre-feet available storage would be about 132 mgd. Adjustment of this yield to a dependable (1 percent chance of shortage) basis would reduce the yield estimates to about 111 mgd. If the yield was then further adjusted to be comparable with the yield of Roaring River Reservoir the incremental first cost for providing 34 mgd from the Hunting Bear Creek Watershed would be about $2,100,000 ([12,263,000 - 5,879,000] x 34/111). Another basis for estimating alternative cost would be from observed cost undertaken by municipal water systems. For this purpose, the cost for 146 various size municipal reservoirs built in Ohio, Indiana and Illinois were utilized. On this basis an alternative project would cost about $1,902,000, including interest accrued during construction. This value was adopted for the measure of benefits of water supply included in the Roaring River Reservoir project. Annual charges for the project (at five percent interest and a 30-year amortization period typical of municipal systems) including operation and maintenance would amount to $164,000.

$1,902,000 x 0.06505 =		$124,000
Annual O&M		40,000
	Total	$164,000

Since additional water supply from Roaring River Reservoir is not expected to be needed until the decade 2000-2010, the value of the alternative was discounted to reflect the present without the future benefits shown. The average annual equivalent of the benefit stream from provisions of water supply is estimated to be $50,000 ($164,000 x 0.30624).

User benefits for the Roaring River Reservoir are summarized in table 6-24.

TABLE 6-24

SUMMARY OF NATIONAL USER BENEFITS
ROARING RIVER RESERVOIR, N.C.

Item	Amount ($1,000)
Flood Control	147
Water Supply	50
Water Quality Control	167
Recreation	217
Total	581

20. EXPANSION BENEFITS

Expansion benefits are divided into 2 categories, redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation and maintenance of the water resource project. Developmental benefits are measured in terms of wage payments made to persons not directly associated with the project, but whose employment results from the economic activity induced by the project.

Redevelopment Expansion Benefits

Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor used in the construction, operation and maintenance of the water resource project. Benefits credited to the national account are the wage payments made to persons who would otherwise be unemployed or underemployed in the absence of the project and who possess the necessary skills for project construction and operation.

Detailed analysis of construction costs of various reservoirs indicate labor cost to be about 20 percent of construction costs, less lands and damages, and about 70 percent of annual operation and maintenance expenditures. Further analysis was made to determine the degrees of skill required for project construction and operation and what portion of these labor skills could be furnished from the locally unemployed or underemployed. The results of these studies are presented in table 6-25.

TABLE 6-25

REDEVELOPMENT EXPANSION BENEFITS BASED ON LABOR EMPLOYED IN CONSTRUCTION, OPERATION AND MAINTENANCE OF ROARING RIVER PROJECT
($1,000)

Item	Expenditure	Labor Costs 1/	Annual Redevelopment Benefits: National Acct 2/	Annual Redevelopment Benefits: Regional Acct 3/
Construction				
Initial	8,820 4/	1,760	29.2	59.6
Future	411	82	1.4	2.8
Sub-totals	9,231	1,842	30.6	62.4
Annual Operation and Maintenance				
Initial	67.0	46.9	7.4	46.9
Future	12.0	8.4	1.3	8.4
Sub-totals	79.0	55.3	8.7	55.3
Total Benefits			39.3	117.7

1/ Labor cost is estimated to be 20 percent of construction cost, less lands and damages; 70 percent of operation and maintenance expenditures.

2/ Labor costs were counted (in the National Account) only for expenditures during the first 20 years. Their present worth was estimated on the basis of a uniformly decreasing annuity (3-1/4 percent interest rate), decreasing from 1 to 0 in 20 years; then spread over 100 years by capital recovery factor for 3-1/4 percent. This remark pertains to the annual figures (O&M); construction costs have been regarded as having occurred in present.

3/ Spread out over 100-year period by capital recovery factor, 3-1/4 percent.

4/ Does not include lands and damages.

Developmental Expansion Benefits

The additions to national and Appalachian regional incomes from subsequent private and public investment decisions, which are encouraged and permitted by the water control afforded by Roaring River Reservoir, in conjunction with the operating W. Kerr Scott and planned Roaring River Reservoirs, have been estimated and are presented below. The fundamental approach is to estimate the magnitude of the investments and their employment effects with and without the project. While an absolute measure of these effects is hardly attainable, a reasonable approximation of the expected value can be made, resulting in a more complete portrayal of the effects of public investment and its role in attaining growth objectives within the region and the nation.

The developmental effects of the Roaring River Reservoir can be classified in three main categories:

1. The effects of flood reduction on urban land use at Elkin-Jonesville;

2. The effects of additional water supply on population and employment in the Winston-Salem area; and

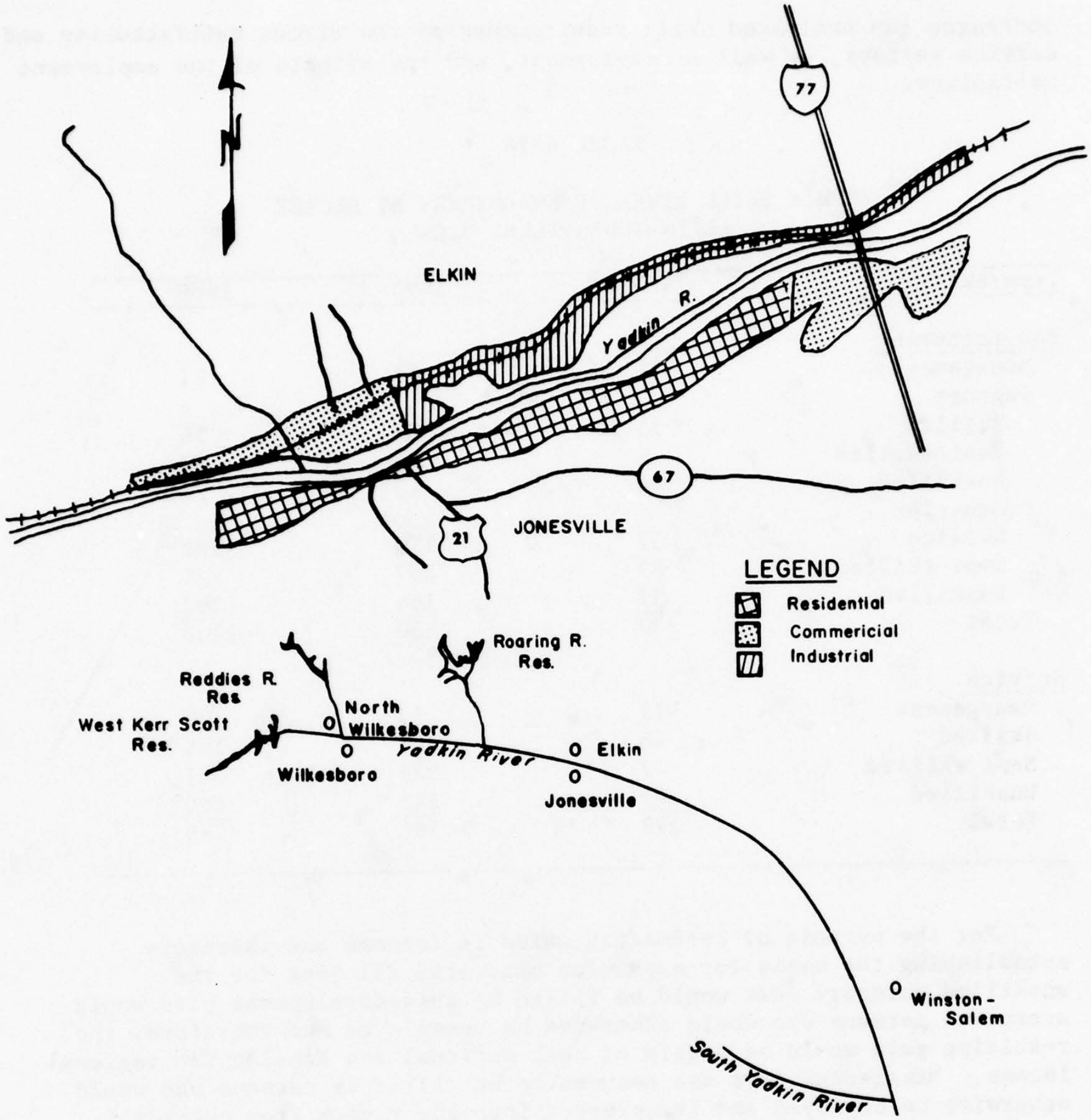
3. The effects of expenditures by recreational users of the projects.

Change in Urban Land Use at Elkin-Jonesville

Approximately 220 acres of land within the urban limits of Elkin-Jonesville (See Exhibit 6-15) will be provided a high degree of protection from flooding given the addition of Roaring River Reservoir to W. Kerr Scott and Reddies River Reservoirs. Of this area, 114 acres would have favorable topography and size to permit efficient urban development. Approximately 53 acres should be prime commercial sites and about 50 acres should be useful for industrial sites because they possess favorable rail and road access, while the remaining 10.7 acres would be used for residential development.

The net increment of the 114 acres attributable to the Roaring River Reservoir would be 30 acres. The developmental plan subsequently presented in this Report will be based on the total 114 acres and the benefits allocated to Roaring River Reservoir on the basis of the fraction 30/114.

The 50 acres of industrial land will take care of the estimated needs for employment in the Elkin-Jonesville area to the year 1995, assuming 1970 is the base year. Following the projections indicated by the benchmarks for the sub-region, employment changes that would be accommodated on this 50-acre area would be 220 by 1980, 650 by 1990, and 1100 by the year 2000. The following tabulation (table 6-26)



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

RELATION OF ROARING RIVER TO THE UPPER YADKIN RIVER GROWTH AREAS

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Date: ________

EXHIBIT 6-15

indicates the estimated skill requirements of the direct manufacturing and service sectors, as well as employment, and the effects of the employment multiplier.

TABLE 6-26

TYPE & SKILL LEVEL OF EMPLOYMENT BY DECADE
ELKIN-JONESVILLE, N.C.

Type/Skill	1980	1990	2000
Manufacturing			
Management	18	52	91
Support			
Skilled	11	32	55
Semi-skilled	6	20	33
Unskilled	4	13	22
Production			
Skilled	37	110	182
Semi-skilled	87	257	425
Unskilled	57	166	292
Total	220	650	1100
Service			
Management	19	57	79
Skilled	48	141	195
Semi-skilled	77	226	321
Unskilled	48	141	195
Total	192	565	790

For the purpose of estimating gains in incomes and therefore establishing the basis for expansion benefits, all jobs for the unskilled category that would be filled by this development plan would accrue to persons who would otherwise be unemployed and therefore, the resulting gain would be a gain of both national and Appalachian regional income. Managerial jobs are assumed to be filled by persons who would otherwise be employed and transferred into the region from outside Appalachia; thus the gains are purely regional. For jobs to be filled in the skilled and semi-skilled categories, the basis for estimating net gains in income (to the nation and to the region) would be the increment of income between the skill required and a job at the next lower skilled classification. These assumptions are required because people having the qualifications to meet skilled and semi-skilled positions would probably be mobile and could move to other areas which would provide them with jobs. However, mobility is not friction-less and in all likelihood, people would remain in the area to take jobs at a lower skill requirement if those were the only openings in the area. Table 6-27 indicates the total yearly gains and income based on the assumptions previously outlined.

TABLE 6-27

GAIN IN INCOME BY DECADE, 1980, 1990, 2000
ELKIN-JONESVILLE, N.C.

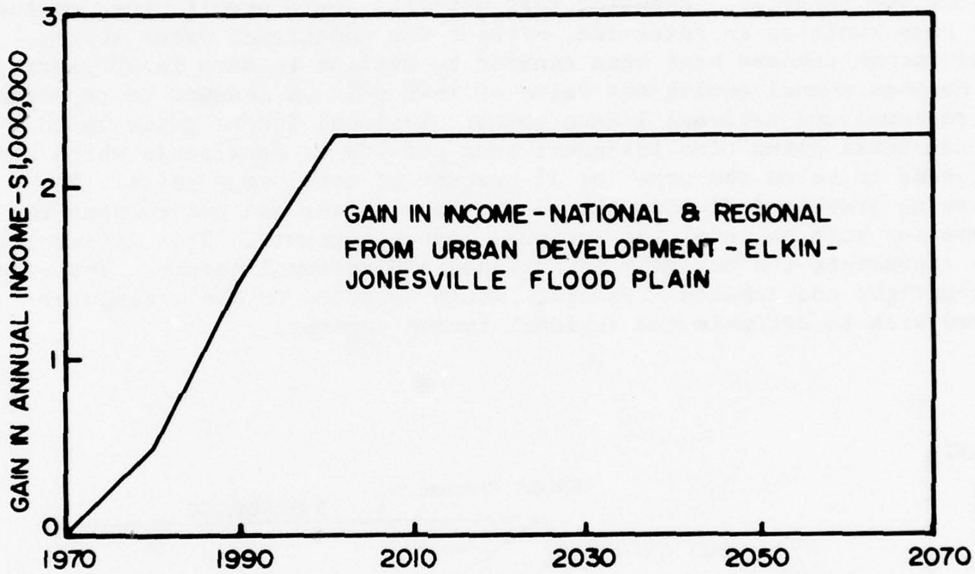
Type/Skill	Number	Net Gain in Annual Income	Total Yearly Gain	Imported
		1980		
Manufacturing				
Management	18			$140,000
Support				
Skilled	11	$ 650	$ 7,250	
Semi-skilled	6	540	3,240	
Unskilled	4	2,600	10,400	
Production				
Skilled	37	1,870	69,190	
Semi-skilled	87	620	53,940	
Unskilled	57	2,700	153,900	
Service				
Management	19			118,000
Skilled	48	1,660	79,680	
Semi-skilled	77	425	31,955	
Unskilled	48	2,080	99,840	
Total	412		$509,395	$258,000
		1990		
Manufacturing				
Management	52			$405,000
Support				
Skilled	32	$ 650	$ 20,800	
Semi-skilled	20	540	10,800	
Unskilled	13	2,600	33,800	
Production				
Skilled	110	1,870	205,700	
Semi-skilled	257	620	159,340	
Unskilled	166	2,700	448,200	
Service				
Management	57			356,000
Skilled	141	1,600	234,060	
Semi-skilled	226	415	93,790	
Unskilled	141	2,080	293,280	
Total	1,215		$1,499,770	$761,000

TABLE 6-27 (Cont'd)

GAIN IN INCOME BY DECADE, 1980, 1990, & 2000
ELKIN-JONESVILLE, N.C.

Type/Skill	Number	Net Gain in Annual Income	Total Yearly Gain	Imported
		2000		
Manufacturing				
Management	91			$710,000
Support				
Skilled	55	$ 650	$ 35,750	
Semi-skilled	33	540	17,820	
Unskilled	22	2,600	57,200	
Production				
Skilled	182	1,870	340,340	
Semi-skilled	425	620	263,500	
Unskilled	272	2,700	734,400	
Service				
Management	79			493,000
Skilled	195	1,660	323,700	
Semi-skilled	321	415	133,215	
Unskilled	195	2,080	405,600	
Total	1,870		$2,311,525	$1,203,000

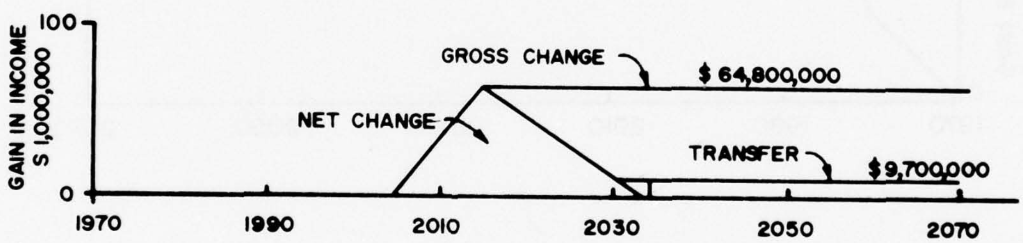
The following figure graphically indicates the changes in net income which would be considered benefit to both the nation and the region from the urban development of the flood plain at Elkin-Jonesville, North Carolina.



Conversion of the income gains to average annual equivalent values, yields total national gains which approximate $1,203,000 annually. The share attributable to Roaring River Reservoir would amount to $317,000 annually. Regional income gains, due to the transfer of income from outside of Appalachia through the importation of management skills plus the national gains would amount to an average annual equivalent of $1,838,000; the share attributable to Roaring River Reservoir would amount to $483,000 annually.

Additional Water Supply to the Winston-Salem Area

The water supply storage included in Roaring River Reservoir will provide about 16 mgd additional dependable yield to downstream users. A deficit in water supply would constrain development of the Winston-Salem Growth Center after the year 2000. When the demand is projected and compared to the anticipated supply, the increase in water supply would be absorbed between the years 2008 and 2013. Projections of employment and the associated population indicates that there would be an increase of manufacturing employment of about 8,000 during the period and about 30,000 total population change. Using an income of about 3,800 dollars per job, the increased annual income after the five-year developmental period would be $30,400,000. The estimated employment multiplier effects of this change in manufacturing employment would indicate total income changes in the area would be on the order of $64,800,000 annually. Assuming that mobility would permit other employment opportunities to intervene, without the additional water supply, gross income changes have been assumed to decline to zero in 20 years. The average annual equivalent value of this gain is assumed to represent net regional and national income gains. Regional income gains would include these gains plus transfers from outside of Appalachia which are estimated to be on the order of 15 percent of total wage gains. The following graphic indicates the estimates of gross and net changes in income for both national and regional income accounts. This triangular area represents the net gain in national and regional income. The area to the right and labeled "transfer" would be added to the triangular-shaped area to estimate the regional income account.



The average annual equivalent of gain to national income when discounted at 3-1/4 percent interest would amount to $6,409,000. The increment of gain to the regional income account would be $7,233,000 from the provision of water supply to the Winston-Salem area.

Expenditures by Recreational Users of the Project

The recreational use of the reservoir and the accompanying facilities will have an impact on incomes for the region and the nation. Assuming that the expenditures of recreation visitors would otherwise be saved, the total expenditure and employment stream thereby created would be a gain. Assuming all expenditures would be transferred, or would be spent on substitutes, there would result no net gain. Bureau of Outdoor Recreation estimates of origin and visitation in Appendix F indicate that 10 percent would be from visitors in excess of 76 miles. This increment of visitation is considered to be from outside Appalachia and their expenditures as net increment to Appalachia. Based on BOR estimates of visitation from over 76 miles, average expenditures would approximate $72,000 and of that total expenditure, about $21,000 would accrue as wages and salaries to persons employed to service recreation needs. Assuming that 49 percent of these wages and salaries would accrue to persons who would otherwise be unemployed, and utilizing a 20-year linear cut-off, total wages accruing to otherwise unemployed would be on the order of $1,600 annually. Utilizing the Wilkes County employment multiplier to indicate the magnitude of total change would result in $3,000 net income benefits. The $3,000 would be a gain, both to the nation and to the region, from the expenditures of recreation users.

A summary of expansion and user benefits for the Roaring River Reservoir by account is presented in table 6-28.

TABLE 6-28
SUMMARY OF EXPANSION & USER BENEFITS ($1000)
ROARING RIVER RESERVOIR, N.C.

Item	National Only	Regional Only	National & Regional	Total National	Total Regional
Expansion Benefits					
Redevelopment	-	78	39	39	117
Development	-				
Urban Expansion - Elkin-Jonesville	-	166	317	317	483
Water Supply - Winston-Salem	-	824	6,409	6,409	7,233
Recreation Expenditures	-		3	3	3
Offset from loss of income from reservoir lands	-		(90)	(90)	(90)
Total Development	-	990	6,639	6,639	7,629
Total Expansion	-	1,068	6,678	6,678	7,846
User Benefits					
Flood Control	12		135	147	135
Water Supply	-		50	50	50
Water Quality Control	42		125	167	125
Recreation	19		198	217	198
Total User	73		508	581	508

SECTION VI - ECONOMIC ANALYSIS

21. ECONOMIC DATA

Project Cost

Annual charges were computed, utilizing data and developing cost estimates presented in Section IV of this Chapter. A summary of costs for the Roaring River Reservoir is shown in table 6-29.

TABLE 6-29

SUMMARY OF COSTS
ROARING RIVER RESERVOIR AND ASSOCIATED INVESTMENT

Item	Amount ($1,000)
Construction Costs 1/	
Lands & Damages	1,243
Relocations	397
Reservoir	163
Dam & Appurtenances	7,378
Recreation	815 2/
Permanent Operating Equipment	628
Buildings, Grounds and Utilities	134
Total	10,758 2/
Annual Charges	
Interest	355
Amortization	15
Maintenance & Operation	79
Major Replacements	20
Total	469
Construction Costs of Associated Investment	93,426
Annual Charges of Associated Investment	1,168
Total Annual Charges	1,637

1/ Includes cost of engineering, design, supervision and administration.
2/ Includes $429,000 for future recreation facilities.

Project Benefits

Annual economic benefits as developed as discussed in Section V are summarized in table 6-30 for the national and regional accounts.

Indices of Performance

One index of performance which is related to economic efficiency can be evaluated by reliance upon the conventional ratio of benefits to cost generally developed for water resources projects. The numerator contains annual user benefits plus those employment benefits contributable to direct construction and operation of water project (redevelopment benefits). The denominator is annual cost of water project.

TABLE 6-30

SUMMARY OF BENEFITS FOR PERFORMANCE INDICES
ROARING RIVER RESERVOIR, N.C. ($1,000)

Item	National	Regional
User	581	508
User and Redevelopment	620	625
Expansion	6.678	7,846

Such an index computed below expresses the minimum index of performance in regard to national income.

$$\frac{620}{469} = 1.3$$

Another index of performance gives a relative measure of the contribution that the Roaring River Reservoir development would make to the objective of expanding employment in the Appalachian Region. The numerator consists of increased wage payments for construction and operation of the water project plus wage and salary flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{7846}{1637} = 4.8$$

22. ALLOCATION OF COST

Costs of the Roaring River Reservoir project were allocated by the separable cost remaining benefits methods modified to accommodate regional income expansion as a purpose. Purposes among which costs are allocated include flood control, water supply, water quality control, recreation, and regional income and expansion. Table 6-31 summarizes the construction expenditures, annual operation, maintenance and major replacements costs, total capital and investment cost, and annual charges. Exhibit 6-16 shows the features of projects utilized in table 6-31. Cost allocation is given in table 6-32.

Alternative Costs

The SCRB method of cost allocation provides that allocated costs should be limited by the lower of either of the benefits of the alternative costs providing each purpose. The alternative cost for flood control, as summarized in table 6-31, was based on actual estimate for a single-purpose flood control project at the site selected for the multipurpose reservoir.

The alternative costs for recreation were developed from statistical data compiled by the Corps of Engineers reflecting costs of single-purpose recreation development, having an impoundment of equal size, undertaken by state parks in the Ohio River Basin. Alternative costs for water quality control were developed by the Federal Water Pollution Control Administration and given in Appendix D of the Main Report. The basis for estimation of alternative costs for water quality and water supply have been discussed previously in paragraph 19.

The value assigned as an alternative cost for regional income expansion is not based on a relevant alternative program for providing similar income effects, because the full range for alternative means for obtaining these benefits have not been evaluated. To maintain the principal of the SCRB cost allocation procedure, the total cost of the water project and associated costs have been entered as a limit on cost to be allocated to regional income expansion.

Separable Costs

The incremental cost for adding each purpose to the multiple-purpose project was calculated by estimating the savings which would accrue if that purpose were omitted and all other purposes were maintained in the project.

TABLE 6-31

SUMMARY OF COSTS ($1,000)
ROARING RIVER PROJECT AND ASSOCIATED INVESTMENT PLAN

Item	MULTIPLE PURPOSE PLAN – Specific Use Lands and Facilities: Flood Control	Water Quality	Recreation	Regional Income Expansion	Joint-use Land and Facilities	Total Costs	Alternate Single Purpose Projects: Flood Control	Water Quality	Water Supply	Recreation	Multiple Purpose Project Less: Flood Control	Water Quality	Water Supply	Recreation	Regional Income Expansion
Construction First Costs:																
ROARING RIVER PROJECT																
Lands and damages			100		1,143	1,243	918				701	1,243	1,243	1,143	1,243
Relocations					397	397	378				334	397	397	397	397
Res. and Pool Preparation					163	163	114				163	95	163	163	163
Dam and Appurtenances					7,378	7,378	7,138				4,756	7,378	6,590	7,378	7,378
Recreation facilities (initial)			386			386					387	387	387		386
Bldgs., grounds and utilities					134	134	134				134	134	134	134	134
Permanent operating equipment		267	—		361	628	361	—	—	—	628	361	628	628	628
TOTAL INITIAL		267	486		9,576	10,329	9,043				7,103	9,995	9,542	9,843	10,329
Future recreation facilities			429		—	429	—	—	—	—	429	429	429	—	429
TOTAL ROARING RIVER PROJECT			915		9,576	10,758	9,043	3,084			7,532	10,424	9,971	9,843	10,758
Economic development plan		—	—	93,426	—	93,426	—	—	—	—	93,426	93,426	93,426	93,426	—
TOTAL CONSTRUCTION COSTS		267	915	93,426	9,576	104,184		3,084			100,958	103,850	103,397	103,269	10,758
Investment Costs:																
ROARING RIVER PROJECT																
Initial construction costs		267	486		9,576	10,329	9,043	3,084			7,103	9,995	9,542	9,843	10,329
Interest during construction		9	16		311	336	294	104	—	—	231	325	310	320	336
Investment, INITIAL INCREMENT		276	502		9,887	10,665	9,337	3,188			7,334	10,320	9,852	10,163	10,665
Future recreation facilities			429			429					429	429	429		429
Economic development plan		—	—	93,426	—	93,426	—	—	—	—	93,426	93,426	93,426	93,426	—
TOTAL INVESTMENT COSTS		276	931	93,426	9,887	104,520	9,337	3,188			101,189	104,175	103,707	103,589	11,094
Annual Financial Charges:																
Initial Increment:																
Interest and Amortization		9	17	1,168	335	1,529	316	108		54	1,417	1,518	1,502	1,512	361
Operation and Maintenance																
Recreation			24			24				25	24	24	24		24
Dam					44	44	42	44		3	43	42	44	44	44
Major Replacement																
Recreation			3			3					3	3	3		3
Dam		—	—	—	15	15	10	15	—	—	14	10	15	15	15
TOTAL INITIAL INCREMENT		9	44	1,168	394	1,615	368	167		82	84	79	86	59	86
Future increment *(discounted)*										29					
Interest and Amortization			8			8				12	8	8	8		8
Operation and Maintenance			13			13				2	13	13	13		13
Major Replacement		—	2	—	—	2	—	—	—		2	2	2	—	2
TOTAL FUTURE INCREMENT			23			23				43	23	23	23		23
TOTAL ANNUAL FINANCIAL CHARGES		9	67	1,168	394	1,638	368	167	50	125	1,524	1,620	1,611	1,571	470

PROJECT FEATURES, COST ALLOCATION STUDIES
ROARING RIVER RESERVOIR N.C.

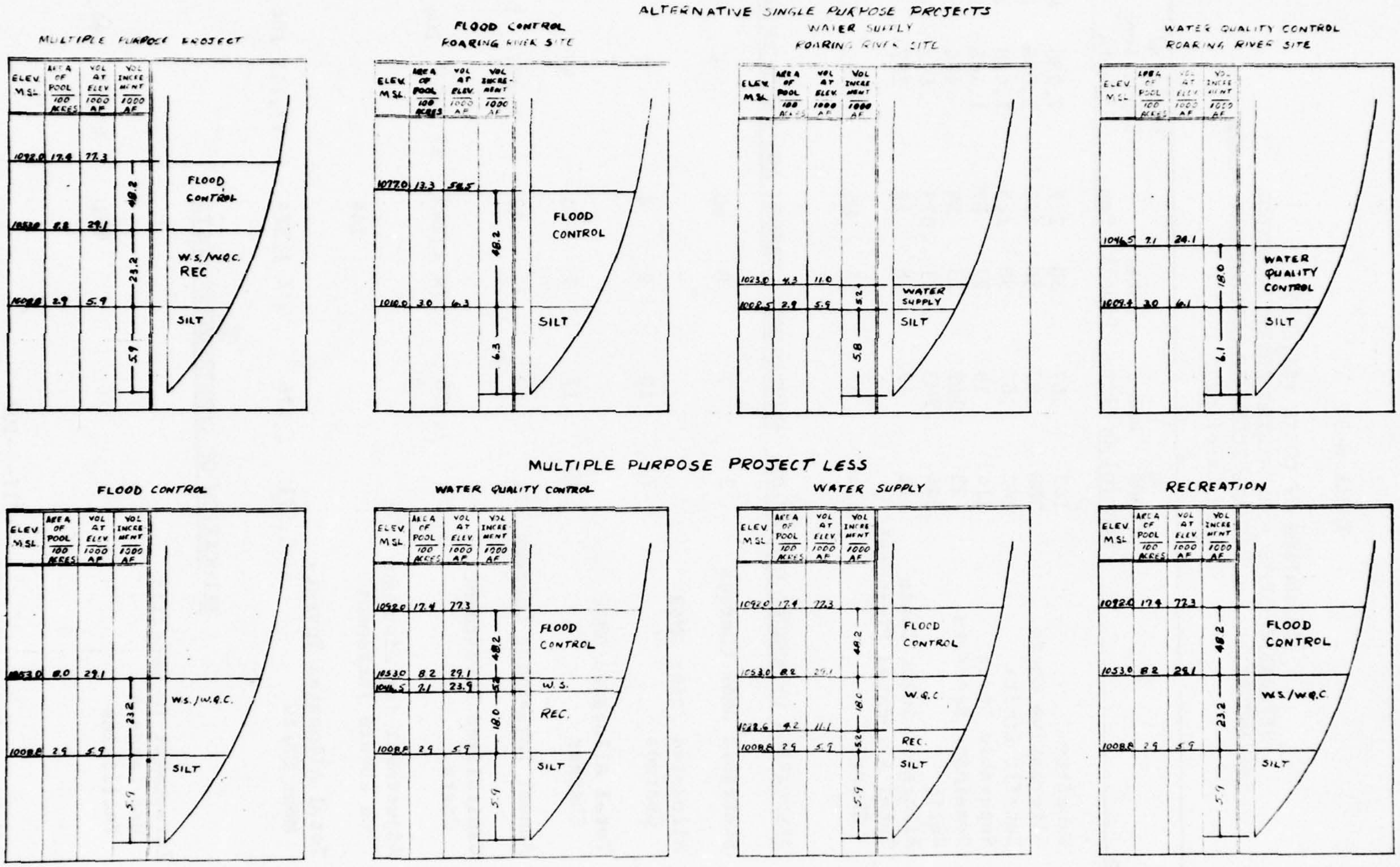


EXHIBIT 6-16

TABLE 6-32

ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
ROARING RIVER PROJECT AND ECONOMIC DEVELOPMENT PLAN
(North Carolina)

Item		Flood Control	Water Quality	Water Supply	Rec.	Regional Expansion Effects	Total
1.	Benefits	147	167	50	217	7,936	8,517
2.	Alternative Costs	368	167	50	125	1,638	2,348
3.	Benefit Limits	147	167	50	125	1,638	2,127
4.	Separable Costs	114	18	27	67	1,168	1,394
5.	Remaining Benefits	33	149	23	58	470	733
6.	Ratio	.045	.203	.031	.079	.642	1.000
7.	Allocated Joint Costs	11	49	8	19	157	244[1/]
8.	Total Allocated Financial Charges	125	67	35	86	1,325	1,638

ALLOCATION OF ANNUAL OPERATION, MAINTENANCE CHARGES AND REPLACEMENT

Item		Flood Control	Water Quality	Water Supply	Rec.	Regional Expansion Effects	Total
9.	Separable OM&R Charges	2	7	0	40	0	49
10.	Allocated Joint OM&R Charges	2	10	2	4	32	50
11.	Total Allocated OM&R Charges	4	17	2	44	32	99
12.	Annual Investment Charges	121	50	33	42	1,293	1,539
13.	Capitalized Investment Costs	3,571	1,476	974	1,240	97,115[2/]	104,376
14.	Adjustment for Discount on Future Increment				144		144
15.	Total Allocated Investment Costs	3,571	1,476	974	1,384	97,115	104,520

ALLOCATION OF CONSTRUCTION COSTS

Item		Flood Control	Water Quality	Water Supply	Rec.	Regional Expansion Effects	Total
16.	Investment in Specific Use Lands & Facilities		276		931	93,426	94,633

TABLE 6-32 (Cont'd)

Item	Flood Control	Water Quality	Water Supply	Rec.	Regional Expansion Effects	Total
17. Investment in Joint-Use Lands & Facilities	3,571	1,200	974	453	3,689	9,887
18. Interest on Joint-Use Lands & Facilities	112	38	31	14	116	311
19. Allocated Construction Costs of Joint-use Lands & Facilities	3,459	1,162	943	439	3,573	9,576
20. Construction Costs of Specific-use Lands & Facilities		267		915	93,426	94,608
21. Total Allocation Construction Costs	3,459	1,429	943	1,354	96,999	104,184
22. Construction Costs of Future Increment				429		429
23. Construction Costs of Economic Development Plan					93,426	93,426
24. Construction Costs - Roaring River Project (initial)	3,459	1,429	943	925	3,573	10,329
25. Total Construction Costs of Roaring River Project	3,459	1,429	943	1,354	3,573	10,758

1/ Restricted joint costs of adding storage for water quality, water supply and recreation.

Annual Charges -	Multiple Purpose Project	2,550
	Less cost of development plan and flood control project	2,453
	Cost of adding WQC, WS & Rec	97
	Less assigned separable costs	107
	Restricted costs	Negative number, use 0 restricted costs

2/ $(\$1,293 - \$1,168) \left(\frac{1}{.03388}\right) + \$93,426 = \$97,115$

Restricted Joint Cost

In the case of water quality, water supply, and recreation, the pool resulting from the storage allocation to the three purposes is jointly used by the three purposes, but not by flood control. Therefore, the cost of adding the total storage increment represented by these three purposes was calculated, the sum of the separable cost already allocated to each purpose subtracted from this gross incremental cost and the residual allocated to each of the three purposes in the ratio of the benefits remains. Separable costs exceed the estimated restricted joint costs for providing the water quality, water supply and recreation pool; therefore, no restricted joint costs remained for allocation.

Joint Costs

Joint costs were allocated to each purpose according to the ratio of benefits remaining after separable costs were allocated.

Recreation Costs

The costs allocated to recreation have been sub-allocated between general and fish and wildlife recreation programs in table 6-33.

TABLE 6-33

ROARING RIVER PROJECT
RECREATION - APPORTIONMENT
BETWEEN FEDERAL & NON-FEDERAL

1. Separable Costs of Recreation	($1,000)
Cost of Multiple-Purpose Project	10,758
Cost of MP Project less Recreation	9,843
Separable Costs of Recreation	915
Lands	100
Facilities	815
Storage	0
Total	915
2. Cost Sharing - Federal	457
Non-Federal	458

Sub-Allocation Apportioned Recreation Costs

Recreation	Benefits ($1,000)	Ratio	Apportioned Costs ($1,000)
General	202	.931	426
F & W	15	.069	32
	217	1.000	458

SECTION VII - COST SHARING

23. APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

Flood Control

All costs allocated to flood control have been apportioned to the Federal Government in accordance with established policy. Flood control benefits are distributed along about 133 miles of the Yadkin River. (See table 6-34.)

TABLE 6-34

APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS
ROARING RIVER PROJECT, NORTH CAROLINA ($1,000)

	Construction Costs			Annual Operation, Maintenance and Replacement Charges		
Item	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Flood Control	3,459		3,459	4		4
Water Quality	1,429		1,429	17		17
Water Supply		943	943		2	2
Recreation	896	458	1,354	4	40	44
Regional Income Expansion	3,573	___	3,573	32	—	32
Total	9,357	1,401	10,758	57	42	99

Water Supply

In accordance with the Water Supply Act of 1958, as amended, non-Federal interests have been apportioned all construction costs allocated to water supply presently estimated at $943,000. Local interests must also assume the annual operation maintenance and major replacement cost allocated to water supply estimated to be $2,000.

Water Quality Control Act

The cost allocated to water quality control has been apportioned to the Federal Government in accordance with Sec. 2, P.L. 87-88, 87th Congress, 1st Session. The Federal Water Pollution Control Administration Report concludes that the benefits of water quality control are widespread.

Recreation

Federal Water Project Recreation Act of 1965 requires that non-Federal interests agree to administer project land and water areas for recreation and fish and wildlife enhancement and bear not less than one-half the separable cost for these purposes, and all the separable costs for operations, maintenance and replacement. One-half of the allocated separable construction cost are estimated to be $426,000, and $32,000, for general recreation and fish and wildlife enhancement, respectively. Operation maintenance, and replacement costs were estimated at $37,000, and $3,000, annually, for general recreation and fish and wildlife enhancement, respectively. The remaining joint-use construction, operation and maintenance expenditures allocated to recreation are apportioned to the Federal Government.

Regional Income Expansion

All costs allocated to regional income expansion have been apportioned to the Federal Government.

24. STATE AND LOCAL ASSURANCES

The requirements for local cooperation for the construction of Roaring River Reservoir are that the State or local interests pay one-half of the separable construction costs allocated to recreation and all the separable costs for operation, maintenance, and major replacement for that function, and for the State or local interests to agree to reimburse the Federal government for the construction and operation and maintenance cost allocated to water supply. Copies of letters from the State of North Carolina indicating the State's intent to cooperate fully in developing the water supply and recreation functions of the Roaring River Reservoir are included as exhibits 6-17 and 6-18.

SECTION VIII - COORDINATION IN PLANNING

25. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture, Commerce, Interior, and Health, Education, and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Charleston District, Corps of Engineers, or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

Many Federal agencies such as the U.S. Geological Survey, Environmental Science Services Administration, and the Office of Business Economics provided basic data for the project planning, such as climatologic, streamflow, economic records, through regular publications or special reports. Other Federal agencies participated indirectly by assisting the State and local agencies in planning groups.

Several agencies made special studies as an aid in formulation of evaluation of the plan of development for the Roaring River Reservoir. Reports of these agencies are included in the appropriate indices to this Report. The following paragraphs concern certain recommendations or views by participating agencies and the actions taken.

Bureau of Outdoor Recreation

BOR surveyed the recreation market area to determine that the demand for recreation opportunities, present and future, exceeds the capabilities of other recreation developments of the project area. They estimated that, at ultimate development, 210,000 recreation days annually could be expected.

No resources of historical or archeological value have been identified in the proposed reservoir on which salvage or preservation would be necessary.

STATE OF NORTH CAROLINA

DEPARTMENT OF WATER AND AIR RESOURCES

GEORGE E. PICKETT, DIRECTOR
E. C. HUBBARD, ASST. DIRECTOR
P. O. BOX 9392
RALEIGH, N. C. 27603
TELEPHONE 829-3003

December 13, 1968

Colonel Burke W. Lee, Jr.
District Engineer
U. S. Army Engineer District, Charleston
Corps of Engineers
P. O. Box 919
Charleston, South Carolina 29402

Dear Colonel Lee:

I have been advised by members of your staff that it is feasible to include in the proposed Roaring River reservoir about 5,000 acre-feet of storage for water supply for municipal and industrial use, which would yield an estimated 34,000,000 gallons of water per day. Forecasts made by this Department show that beginning in the period 1990 - 2000 the upper Yadkin River basin will become the major source of raw water supply for the general area of Forsyth and Davidson Counties. These counties are part of a fast-growing Piedmont Crescent area that includes Winston-Salem, Thomasville, and Lexington. It is estimated that it will be necessary to provide for doubling the present minimum flow in the Yadkin River near Winston-Salem, which is now about 160 million gallons per day, to meet anticipated requirements for water supply withdrawals in the year 2000. The water supply storage which could be included in the Roaring River project could make a valuable contribution to meeting this requirement.

The State of North Carolina desires that the water supply storage be included in the Roaring River project, in order to secure this resource for use by local governments when it is needed. The State intends to give assurances or repayment for the cost of construction, operation, and maintenance of the storage when it is required. It further intends to transfer or assign this obligation, upon their request, to counties or municipalities, and that they shall execute suitable contractual arrangements when needed; and to stipulate that counties or municipalities shall repay to the State of North Carolina, as and when their requirements are known, those portions of the cost which are expended on their behalf.

Sincerely,

George E. Pickett

George E. Pickett

EXHIBIT 6-17

STATE OF NORTH CAROLINA

DEPARTMENT OF WATER AND AIR RESOURCES

GEORGE E. PICKETT, DIRECTOR
E. C. HUBBARD, ASST. DIRECTOR
P. O. BOX 9392
RALEIGH, N. C. 27603
TELEPHONE 829-3003

July 18, 1968

Colonel Burke W. Lee, Jr.
District Engineer
U. S. Army Engineer District, Charleston
P. O. Box 919
Charleston, South Carolina 29402

Dear Colonel Lee:

This is in reply to your letter of May 23, 1968, concerning local cooperation in the recreation and fish and wildlife features of the projects proposed in your report on "Development of Water Resources in Appalachia" for Sub-Region D. The projects concerned are the Clinchfield Dam and dams on the Roaring, Mitchell, and Fisher Rivers in the Upper Yadkin River Basin.

In accordance with the provisions of the Federal Water Project Recreation Act, PL 89-72, the State of North Carolina will give assurance of fulfillment of the following:

a. Administer project lands, facilities, and water areas for recreation, and assure access to such development to all on equal terms;

b. Contribute in kind no less than one-half of the separable first costs allocated to recreation, presently estimated at $4,483,000;

c. Bear all separable costs of operation, maintenance, and replacements of fish and wildlife and recreation use lands and facilities, presently estimated at $746,000 annually.

The figures given above may be further broken down as follows:

	First cost	Annual operation, etc.
Clinchfield Dam	$3,243,000	$629,000
Roaring River Dam	429,000	40,000
Mitchell River Dam	271,000	26,000
Fisher River Dam	540,000	51,000
Totals	$4,483,000	$746,000

The State agency having administrative jurisdiction over fish and wildlife does not feel that the proposed projects provide enhancement of the fishery, and does not ask for enhancement under the provisions of Sec. 2 (a) (3) of PL 89-72. However, it is the desire of the State that all recreational and fish and wildlife values be developed to their maximum potential, and on behalf of the State I do agree with the values of the benefits as set forth in your report and in the assurances given above. It is our intention that these values will be developed in full by State or local interests, and we have in existence programs which will do so. Note that it is contemplated that the local cooperation will be furnished "in kind", and by the assumption of responsibility for administration, operation, maintenance, and replacements.

Sincerely,

George E. Pickett

George E. Pickett

Fish and Wildlife Service

The Fish and Wildlife Service evaluated the fish and wildlife conservation and enhancement aspects of the Roaring River Reservoir and their report is included in Appendix G to this Report.

As recommended by the Fish and Wildlife Service the following provisions have been incorporated into the plan of development: Fisherman access would be provided to project water and to tailwater fishing areas. The Service's recommendation for acquisition of about 200 acres of land located outside the project area adjacent to the general purchase unit boundaries of the Thurmond Chatham Wildlife Management Area will be implemented as part of the Reservoir Development Plan, to mitigate hunting losses occasioned by construction and operation of the reservoir. A minimum release of approximately 20 cfs will be maintained at all times to avoid damages to fish habitat during periods of low flow and to meet riparian obligations (unless inflows fall below this value, in which case inflows will be released). Reservoir clearing will be coordinated in subsequent planning stages with representatives of the Fish and Wildlife Service and the North Carolina Wildlife Resources Commission and the North Carolina Department of Health. The reservoir operation schedule will be coordinated with the representatives of the North Carolina State Wildlife Resources Commission to minimize any adverse effects of project operation on fish and wildlife enhancement, while meeting the requirements that other purposes of the reservoir would impose. Maintenance of the maximum conservation pool during the recreation season, consistent with requirements for withdrawals for water supply and water quality control purposes downstream and to provide maximum safety in regards to flood control hazards, will be made to protect maximum recreation use by the public.

Federal Water Pollution Control Administration

The FWPCA has evaluated the need for and value of water quality control releases from the proposed Roaring River Reservoir and reported on the project in Appendix D to this Report.

26. STATE AGENCIES

Coordination has been maintained throughout the course of these studies with the North Carolina Department of Water and Air Resources, and complementary State agencies involved in conservation, fish and wildlife, recreation, etc.

27. PUBLIC HEARINGS

Public Hearing at Winston-Salem, North Carolina, 4 January 1968. A potential plan of development for the Appalachian portion of the Yadkin River Basin was presented and statements from interested parties concerning the plan were received. Approximately 109 persons attended

the hearing including state, county, and municipal officials, representatives of civic organizations and interested individuals. The State of North Carolina indicated strong support for the study and indicated full cooperation with the District Engineer in carrying it to completion. A prepondance of the statements read at the hearing indicated favorable and complete support for the plan of development, including Roaring River Reservoir and the only statements which can be construed as critical were directed to the timing of the development. However, the necessity for early completion of Reddies and Roaring River Reservoirs was recognized and overwhelmingly endorsed by those who read statements at the hearing.

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 7

CURRY CREEK RESERVOIR PROJECT

ALTAMAHA RIVER BASIN, GEORGIA

Office of Appalachian Studies

Corps of Engineers

September 1969

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PART III

PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

TABLE OF CONTENTS

PART III

PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

PART III

PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

PART III

PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

PART III

PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

TABLE OF CONTENTS
(Cont'd)

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

LIST OF TABLES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

LIST OF TABLES
(Cont'd)

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

LIST OF EXHIBITS

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

LIST OF FIGURES

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PART III
PROJECT ANALYSES

CHAPTER 7 - CURRY CREEK RESERVOIR PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Curry Creek multiple-purpose reservoir site is located in the Piedmont Plateau in Jackson County, Georgia, about 12 miles northwest of Athens (See Exhibit 7-1). The damsite is on the North Oconee River, about 1/4 mile below the mouth of Curry Creek, in the headwaters of the Altamaha River Basin. The project would control the runoff from 181 square miles.

Principal physical features are the 1,200-foot dam consisting of a 700-foot concrete section, including a 90-foot gated spillway, and impervious earthen embankments; a 180-foot dike, 12 feet high, in a saddle northeast of the dam; and appropriate outdoor recreation facilities surrounding the 5,720-acre lake. The maximum height of the dam is 85 feet, and the capacity of the reservoir is 180 thousand acre feet, equivalent to about 18.6 watershed inches.

2. PROJECT IMPACT

This water resource project would provide goods and services to the Cities of Jefferson and Commerce, the downstream river valley, and the potential growth area centered at Athens, thereby removing the water constraints which could hinder future development. Water-related needs to stimulate economic expansion in this northeast Georgia Appalachian area have been identified as water supply, flood control, recreation opportunities, and aesthetic enhancement.

The water supply storage of the reservoir will meet present needs and the specific projected demands of the cities of Athens and Commerce and other parts of the study area to year 2020. Assurance of an adequate water supply will eliminate an effective deterrent to future economic growth and encourage development of water districts and other water supply systems to serve the area. Flood damages along the downstream North Oconee River above Athens will be virtually eliminated. Damages in Athens will be drastically reduced, and along the river below Athens appreciably diminished. Operational releases of occasional impoundments of floodwaters and from conservation storage to downstream water supply diversion points will alleviate objectionable channel and streamside conditions which presently develop during seasons of deficient streamflow. The 5,720-acre reservoir and recreation facilities adjacent thereto are expected to provide 1,500,000 recreation days annually by about year 2020. The reservoir, downstream fisheries, and 700 acres of lands to be provided for wildlife

use are expected to provide 98,200 user days for fish and wildlife pursuits. The provision of additional employment opportunities both during and after project construction would support the projected economic development.

3. COST AND BENEFITS

Construction cost for the Curry Creek project is estimated to be $18.5 million with equivalent annual charges of 726,000 dollars. Associated development investments are estimated to be $8.8 million and with annual charges of 296,000 dollars. Annual benefits for the development are estimated as follows:

	BENEFITS	
	National	Regional
Users of the water Project Services	$1,107,000	$ 587,000
Expansion Effects		
Redevelopment	67,000	238,000
Development	404,000	4,248,000
Total Expansion	471,000	4,486,000

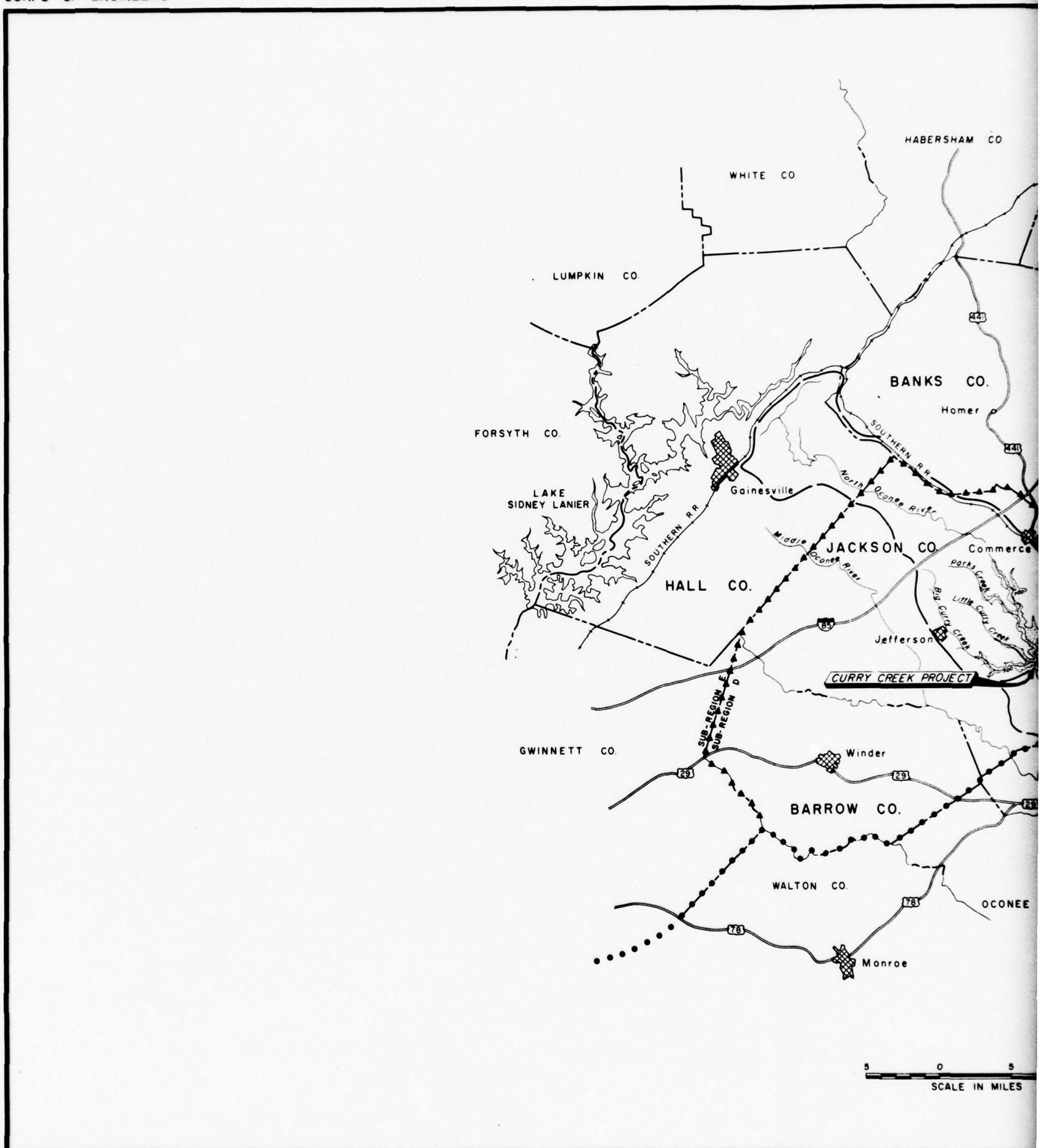
Using the preceding, the ratio of user plus redevelopment benefits to water project costs, indicates a minimum index of performance in relation to increasing national income and results in an index of performance of 1.6. The ratio of total regional benefits to total costs indicates an index of performance in regards to increasing regional income of 4.4.

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accordance with present Federal policy, costs of the Curry Creek Reservoir have been apportioned between Federal and non-Federal interests. The Corps of Engineers would construct and operate the project. Operation of the reservoir project would be shared with non-Federal interests who would operate the general outdoor recreation and fish and wildlife lands and facilities. Operation would be coordinated with those interests which acquire rights to storage space for water supply.

Construction costs allocated to water supply would be apportioned to non-Federal interests who would reimburse the Federal Government under provisions of the Water Supply Act of 1958, as amended, (PL 85-500). Construction costs and operation and maintenance costs allocated to flood control would be apportioned to the Federal Government under applicable flood control legislation since flood control benefits are widespread, extending about 12 river miles downstream.

CORPS OF ENGINEERS



U. S. ARMY

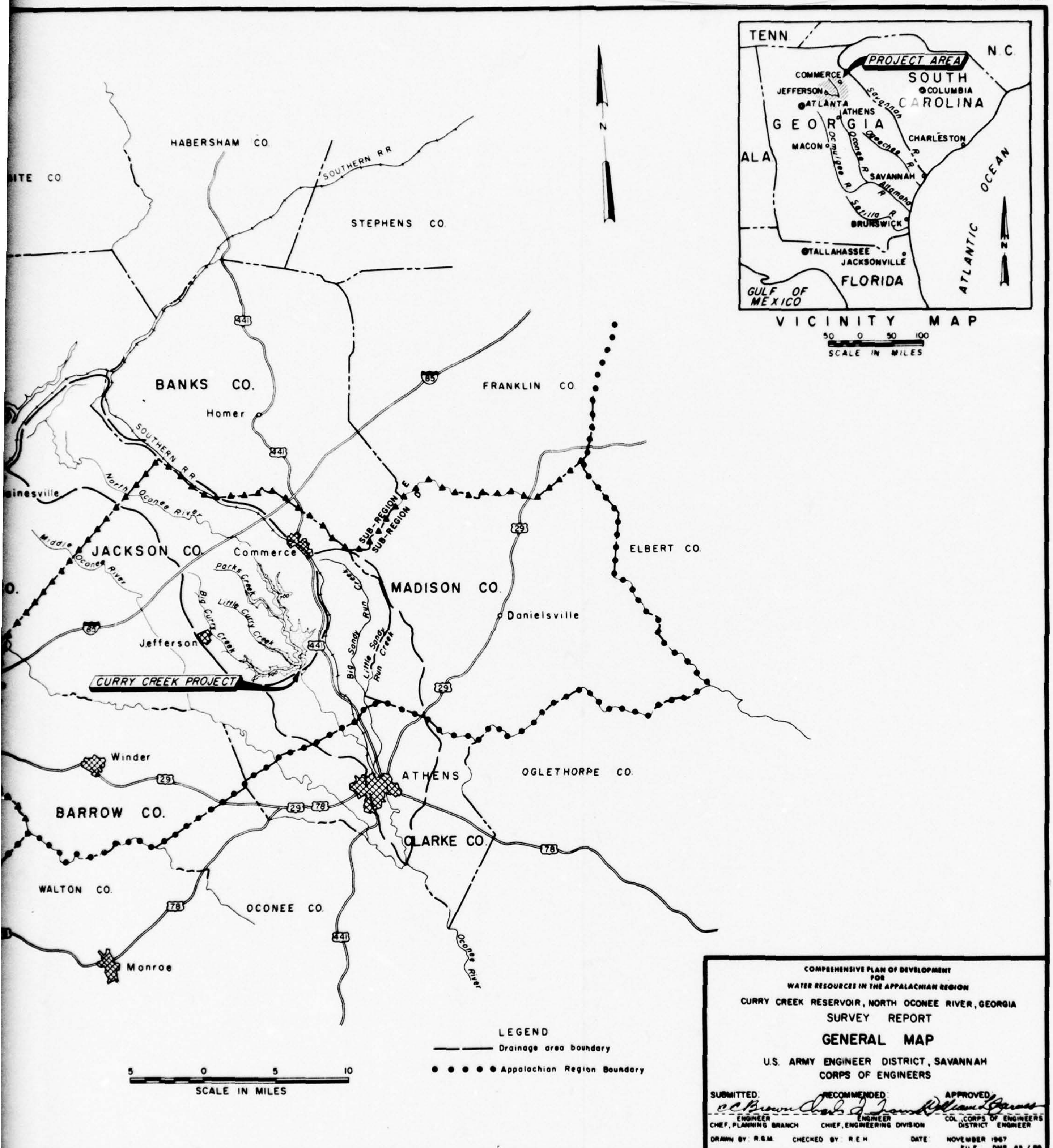


Exhibit 7-1

The Federal Water Pollution Control Administration (FWPCA) in their evaluation of water quality control needs did not find that storage in the Curry Creek Reservoir for this purpose was warranted. However, the State Water Quality Control Board in Georgia has expressed a concern that adequate consideration has not been given for stream flow augmentation. Should, in the future, a need be found for water quality control, the project could be reformulated to include this purpose.

One-half of the separable costs of recreation (including fish and wildlife enhancement measures) are apportioned to non-Federal interests, who must agree to operate and maintain the facilities and lands under provisions of the Federal Water Projects Act, as amended (PL 89-72). Therefore, the remaining separable costs and all joint costs allocated to recreation are apportioned to the Federal Government. A summary of apportioned costs is presented in the following tabulation:

	Apportioned Construction Costs ($1,000)	
	Federal Government	Non-Federal Interests
Purpose		
Flood Control	2,983	--
Water Supply	--	2,026
Recreation	4,469	4,029
Regional Income Expansion	4,250	--
Total	11,702	6,055

Prior to construction, non-Federal interests should execute an agreement to repay their share of the apportioned costs; establish downstream encroachment lines to permit efficient reservoir regulation; contribute to the pollution control by providing adequate treatment or other waste control methods; and to the full extent of their legal capability prevent pirating of water supply streamflow, when releases of such flows use the natural stream channels for conveyance.

5. WATER-RELATED NEEDS AND PROJECT DEVELOPMENT AS SOLUTION

The project is located in the center of one of the fastest growing areas in the nation. The industrial belt of South Carolina, Greensville-Spartanburg-Anderson, northeast of the project and the Atlanta Metropolitan area west of the project, has a very favorable growth rate. Augusta to the east, Macon to the south, and Gainesville to the north, all in Georgia, are also experiencing a rapid rate of growth. The growth of these areas is attributed not only to expansion of the "old line" industries such as textiles, but also to the numerous new diversified industries locating in the area. Athens, Ga. is one of the cultural and educational centers of the state. The growth of the area may be attributed not only to expansion of the University of Georgia, one of the major educational institutions of the nation, but also the many diversified industries that have located in the area. With this growth there have arisen several water related problems that must be resolved if further industrial expansion is to continue. Athens is located on the North Oconee River, immediately upstream of the junction of the Middle and North Oconee River and lies between the two rivers. Many of its water problems can be solved by proper development of the North Oconee River.

There are approximately 2,600 acres of land lying in the flood plain between the junction of the Middle and North Oconee Rivers and the potential damsite. Flooding of these lands by the North Oconee River has caused several problems. One of the more desirable industrial parks of Athens lies partly within the flood plain and land use has been limited to waste areas or low-productivity pasture uses due to flooding. Approximately 350 acres are presently in limited farm production.

The City of Athens' water system furnishes water not only to the municipality itself, but also to a large rural area which includes the southwestern portion of Madison County. The supply is taken from the North Oconee River which had a computed low flow of 10.3 mgd in 1954. The peak water demand for the system was 10.2 mgd through the year 1967. As of June, 1969, the City of Athens has already reached a peak of 12 million gallons a day. Thus, it can be seen that, with the increasing demands and any coincident low flow period, there may be a shortage of raw water.

Table 7-1 shows the estimated water supply needs through the year 2020. These needs include municipal and industrial requirements but does not include industries which may desire a large independent supply.

TABLE 7-1
WATER SUPPLY NEEDS

County	Percent of County*	Benchmark Population - Year 1980	2000	2020
Banks	50	**	4,200	4,300
Barrow	50	**	**	19,288
Clarke	100	75,000	102,000	130,000
Hall	33	**	34,000	51,333
Jackson	100	22,052	25,154	30,317
Madison	50	6,146	6,455	7,371
Oglethorpe	67	**	5,360	5,360
Oconee	100	7,500	9,800	12,000
Total population	-	110,698	186,969	259,969
Water supply needs	-	23 mgd	41 mgd	60 mgd

* Area served by Curry Creek Project.
** Not a part of distribution system at this time.

An evaluation of water supply and water quality control needs for the North Oconee River was made by the Federal Water Pollution Control Administration (See Appendix D). This initial evaluation revealed that water quality control storage was not needed in the Curry Creek Reservoir. However, the State Water Quality Control Board has expressed a concern that adequate consideration has not been given for stream flow augmentation. For this reason, it is anticipated that an additional study will be made during preconstruction planning to determine in more detail the water quality control needs.

The Bureau of Outdoor Recreation (BOR) has made an evaluation of the need for additional facilities to accommodate present and future water related outdoor recreation needs (See Appendix F). It is in close agreement with the estimate of recreation needs developed by this office. The basis of the estimates is described in the following paragraphs.

A 16-county area of Northeast Georgia and certain parts of neighboring Standard Metropolitan Statistical Areas represent the prime source of recreational users of the Curry Creek Reservoir. The current population of this area is estimated at 570,000 and it is projected to double by the year 2000 and income is projected to triple in the same time.

Lake Sidney Lanier (CE), Hartwell Reservoir (CE), Clark Hill Reservoir (CE), Sinclair Lake (Georgia Power), and Jackson Lake (Georgia Power), are operating projects within about an hour's drive of Athens. The first three projects are very heavily utilized at the present time, providing about 20 million visitor days of recreation opportunity in

1968. The Georgia Power projects are also being used by recreational visitors. Any reasonable projections of per capita use of the Curry Creek Project after allowance for the above mentioned projects indicate that the effective population (570,000) would make several visits each year. Increases in income, combined with improved highways, would result in a further increase in per capita visitation. Thus the ability of the reservoirs and associated land to support adequate facilities would appear to form an upper limit on use.

The presence of the large water surfaces indicated above fills needs for boating until the year 2000, but a deficit for other facilities is current. A need for additional lands and facilities to accommodate fishing and hunting exists. Program management of project lands, reservoir and domestic areas could enhance opportunities for fishing and hunting.

In order to preserve and enhance the environment in the Curry Creek Project Area, the fish and wildlife plan will include the project acquisition of an additional 700 acres of land. In conjunction with this area, a water control structure will be located on Cabin Creek so as to flood hardwood areas at a shallow depth during fall and early winter months. Further consideration will be given to the preservation and enhancement of areas of unique scenic, archeological, historic, and natural scenic values.

6. ALTERNATIVES FOR MEETING NEEDS OR REMOVING CONSTRAINTS

Studies were made to determine what measures could effectively meet the needs. These studies included non-structural alternatives, flood proofing, single-purpose projects, multiple-purpose projects at other sites, and various combinatins of these studies. A local protection project for Athens could provide the desired degree of protection for the city but costs would exceed flood control benefits. Development of a system of small upstream reservoirs to provide the range of water services included in a large multiple-purpose reservoir and to provide an equivalent degree of flexibility of future operational choices would appear to cost more than the Curry Creek Project. For instance, costs allocated to flood control for the upstream watershed projects in the investigated or planned studies amount to about $1,359,300 for 10,924 acre feet, an average of about $124 per acre foot as compared to an allocated cost of $77 per acre foot for flood control space in the potential Curry Creek project. Water supply from Lake Lanier or a similar reservoir in adjacent basins would be more costly than the proposed project due to the cost of longer transmission lines and their operation and maintenance. Development of groundwater sources would appear to be more expensive than surface storage because of relatively poor yields and the extensive well fields which would have to be developed to supply the levels of forecasted needs. Non-structural alternatives such as flood plain zoning, flood proofing, and evacuation were considered. These methods appear to be effective complementary tools of flood plain management with structural measures.

The most efficient alternatives for flood control and water supply were single-purpose reservoirs at the Curry Creek site. Generally

equivalent state park recreation facilities would be the most efficient alternative to those of the Curry Creek Reservoir project.

Four sites on Curry Creek were evaluated as alternatives to the selected site. The selected site appeared to offer the most preferable alighment of spillway and dam, an adequate source of construction material and a balanced supply of access points for recreational use.

7. SIZING PROJECT TO MEET NEEDS

The proposed Curry Creek Reservoir was further analyzed to determine the storage allocations needed to accomplish the various project purposes, and to assure optimum project development. The allocation needs are discussed in the following paragraphs.

Sediment

Hydrologic studies indicated that the 100-year sediment deposition in the reservoir would be about 14,000 acre feet. The storage below elevation 661 was provided for this purpose to accommodate this deposition without impairing other project functions. In addition, the recommended USDA North Oconee River Upstream Watershed Project and accelerated land treatment program for the drainage area above Curry Creek Reservoir Project, will further reduce sediment production and deposition.

Water Supply

According to local planners, changes are now occuring that should help bring into realization the benchmark population and development. Several trends and developments were considered in estimating water supply needs. A four-lane highway connecting Athens with Atlanta is beyond the planning stage. Three other four-lane highways will pass through the area within 15 years. There are additional demands to be expected from rural water districts now being encouraged through the USDA Farmers Home Administration and other Federal agencies.

The location of a textile finishing plant and a chicken processing plant within Appalachia would result from an assurance of an adequate water supply prior to initiation of construction. These are considered in the water supply needs of the project. The market area for the project has the prerequisites for continued industrial expansion providing an adequate supply of water is assured. Much of the market area lies outside of the Appalachian area including the major growth center of Athens. There has been little attempt to evaluate the effects the project would have on the industrial complex outside of Appalachia due to the difficulties encountered in relating the benefits to the Appalachian area. From the favorable climate for industrial expansion, it is not unreasonable to

assume that other water related industrial plants will locate in the area. For instance, predictions for the year 2000 indicate that Georgia will be expected to increase its pulp and paper output equivalent to that of four plants. It is within a reasonable possibility that at least one pulp mill would take advantage of the efficiency of production which the Athens area could offer. The proposed project formulation is such that storage reallocations could be made in the future, even after construction.

A storage-yield curve for the Curry Creek Reservoir is presented in paragraph 9. The total water supply need of 60 mgd (See Table 7-1) would require a storage of 27,000 acre feet. Therefore, 27,000 acre feet of storage in the conservation pool will be allocated to water supply.

Recreation

An unsatisfied demand for recreation in the project area before the year 2000 will be brought about by an increase in population and interest in recreation. Therefore, a permanent pool was included in the project which was large enough to satisfy a portion of these needs. An attempt was made to size the multiple-purpose reservoir to its maximum potential with the limiting factor being Jefferson, Georgia. A conservation pool at elevation 700 would satisfy a regional need immediately and would increase to an ultimate in general recreation user days of 1,500,000 by year 2020. It would also provide for an increase in fish and wildlife recreation of 98,200 user days, including 1,920 for downstream fisheries.

A smaller pool at lower elevations would not meet as much of the need due to reduction in area, difficulties of access, and lack of as many favorable recreation sites. Any increase in pool elevations would encroach on the City of Jefferson, thus entailing purchase of costly urban real estate.

Flood Control

Stage reductions afforded by the Curry Creek Reservoir were determined by routing various floods through the reservoir. Reservoir holdouts thus determined were then routed down North Oconee River to evaluate the reductions at the index station at Athens, Georgia. It was determined that a 6-inch storage would provide the necessary protection well beyond the 100-year frequency. It was also determined that there was no difference in the stage-frequency curve modified by flood control storage of four and six inches until approximately the 500-year frequency. Therefore, flood control storage of 4 inches (39,000 acre feet) was chosen. An exhibit in paragraph 9 gives the natural and modified stage-frequency curves.

Surcharge Storage

Routing the spillway design flood through the proposed reservoir using the proposed gated spillway would require a surcharge storage of 88,000 acre feet.

8. SELECTED PROJECT

The project location is shown on Exhibit 7-1. The proposed Curry Creek Dam would be about 1,200 feet long and 85 feet high, including a 90-foot spillway controlled by three 30 x 25-foot gates. Additional structural details are described in paragraph 11 and depicted on Exhibit 7-2. A map of the reservoir area is shown on Exhibit 7-3.

The elevations of the various pools and the equivalent storages and areas are given in the following tabulation:

Item	Elevation (Ft.msl)	Volume (Accumulative) Ac.Ft.	Inches	Pool Area (Acres)
Top of dam	724	-	-	-
Flood control pool	706	180,000	18.65	6,600
Conservation pool	700	141,000	14.61	5,720
Sediment pool	661	14,000	1.45	1,120

The multi-purpose reservoir project presented herein would provide protection from the 100-year frequency flood for the area in Jackson and Clarke Counties from the damsite to Athens. The stage of the 1966 flood in Athens would be reached once in 75 years under project conditions as compared to once in 13 years under present conditions. It would provide ample water supply storage to meet projected municipal needs of the cities of Athens, Jefferson, and other areas in the project study to year 2020 as well as provide for some water related industrial expansion.

Provision of a dependable supply of water removes an effective deterrent to the further economic development of the study area. Since Jackson County provides a primary growth center for the area, a developmental strategy oriented towards encouraging the growth of this County will provide a source of employment for the surrounding counties within commuting distance. Athens could even reach a plateau in its growth pattern by 1970 due to a shortage in dependable water supply. The reduction of periodic flooding and provision of quality outdoor recreation opportunities by the multiple-purpose Curry Creek project would add a further dimension to the attractiveness and competitiveness of the area to support further industrial expansion.

Timely development of rural and suburban water districts in this area will be encouraged by the provision of adequate supplies in the multiple-purpose project. The trends of such development are considered to be highly likely in several counties of the study area. Consolidated treatment and distribution networks offer meaningful economies to such development and provide an institutional advantage towards cooperative development.

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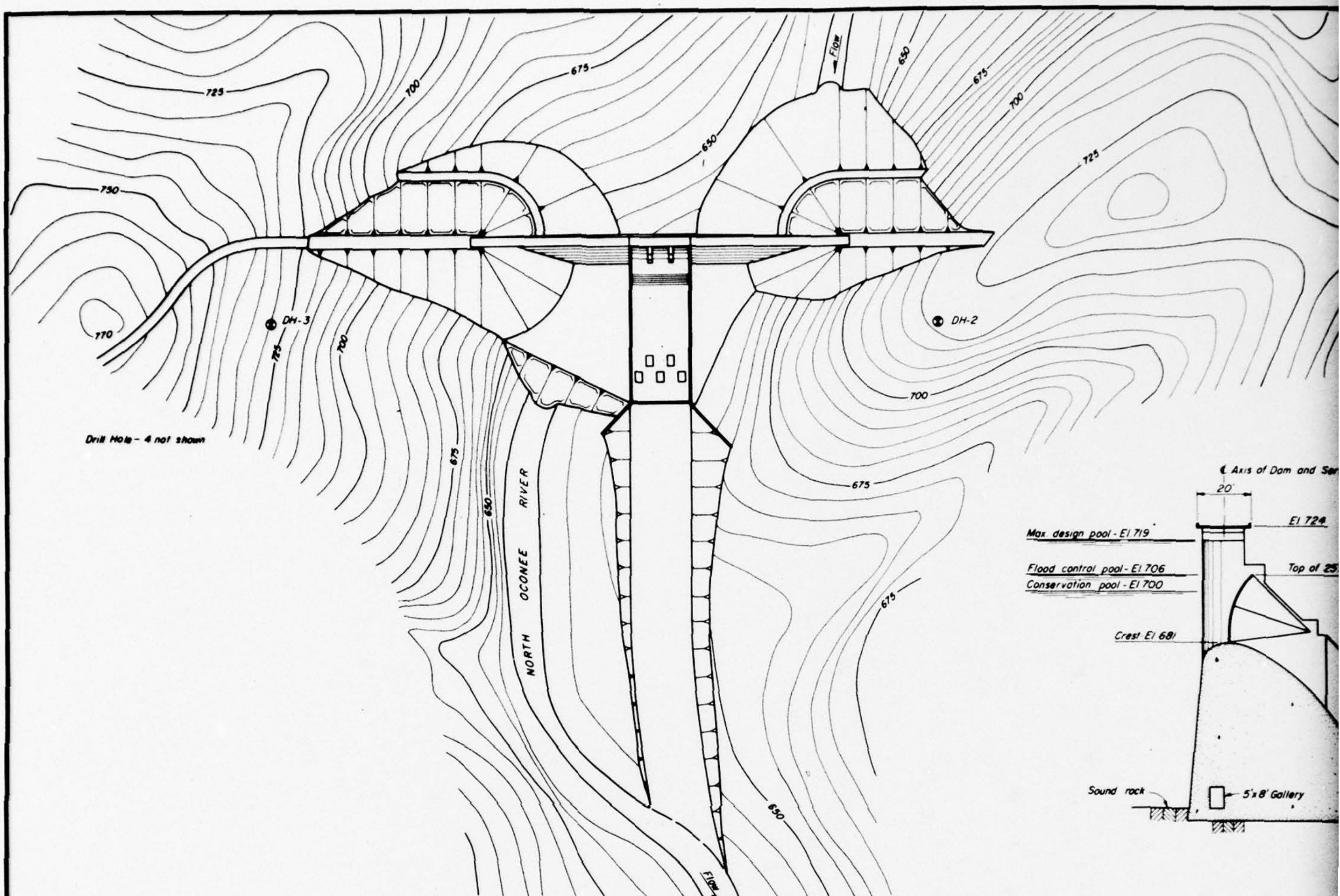

PLAN

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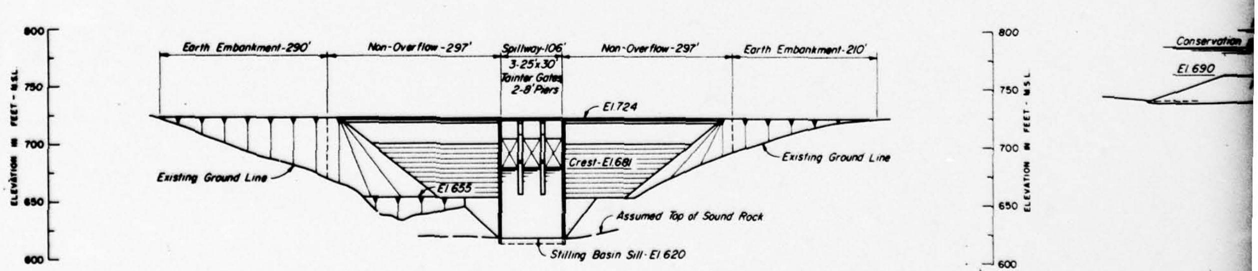

DOWNSTREAM ELEVATION

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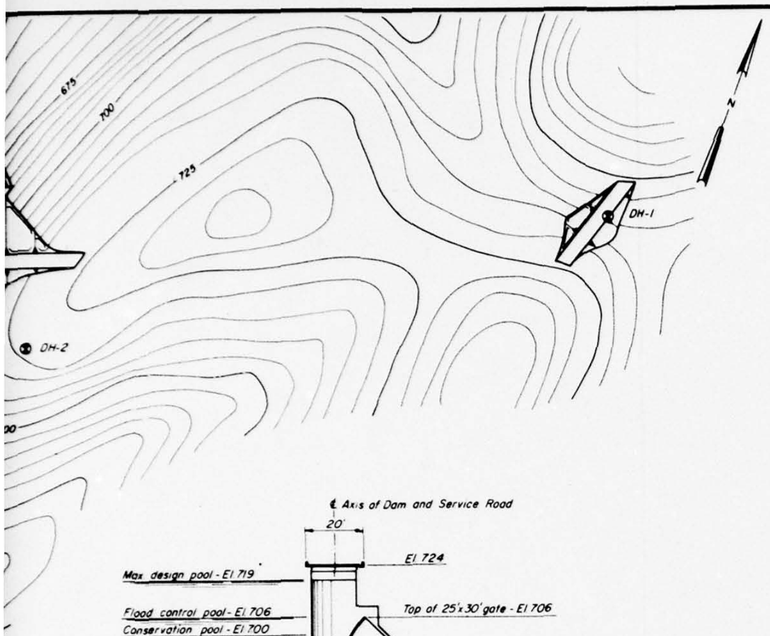

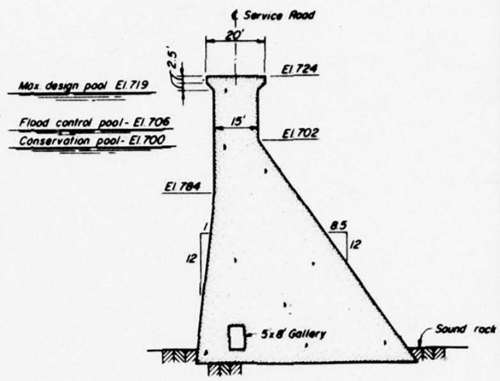

NON - OVERFLOW SECTION

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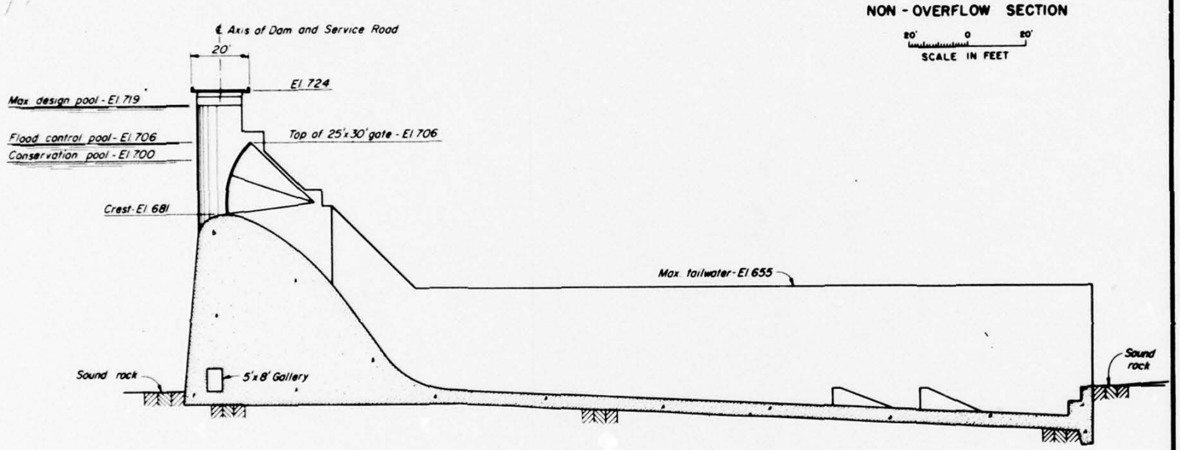

SPILLWAY SECTION

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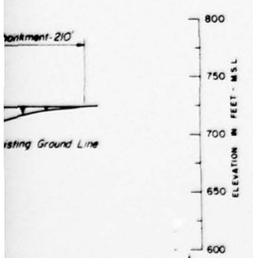

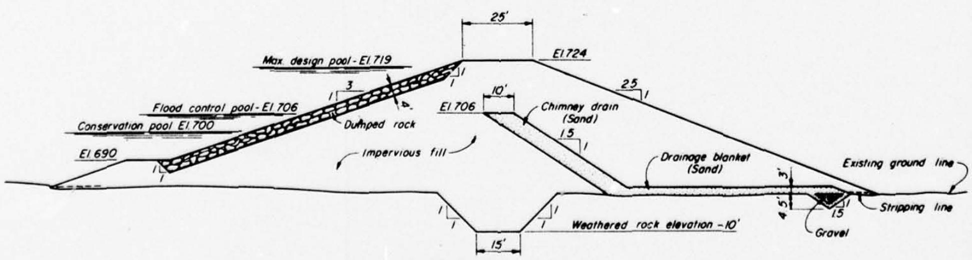

EMBANKMENT SECTION

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SCALE IN FEET

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
PLAN, ELEVATION AND
CROSS SECTIONS OF DAM

SCALE
AS SHOWN

Exhibit 7-2

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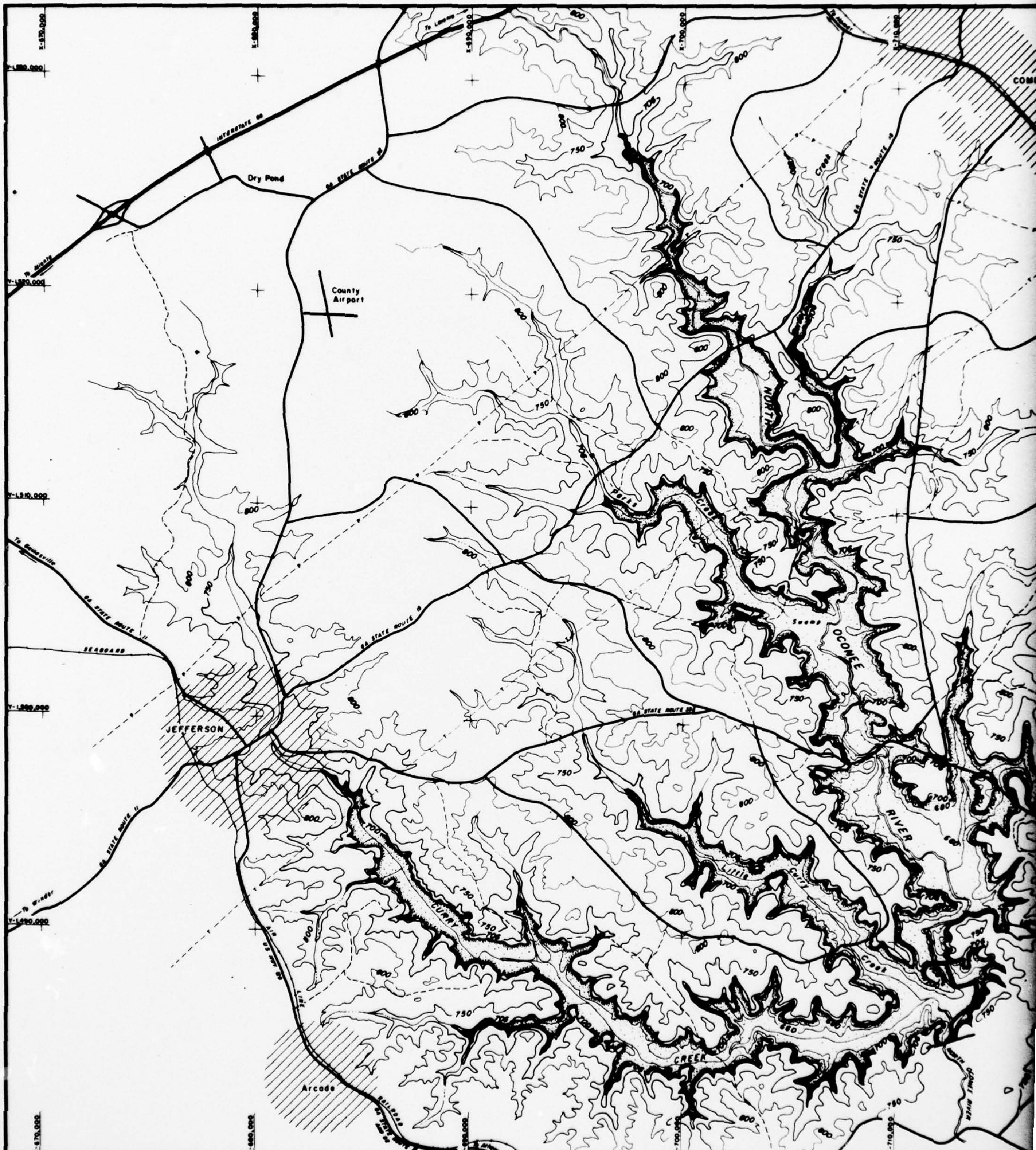

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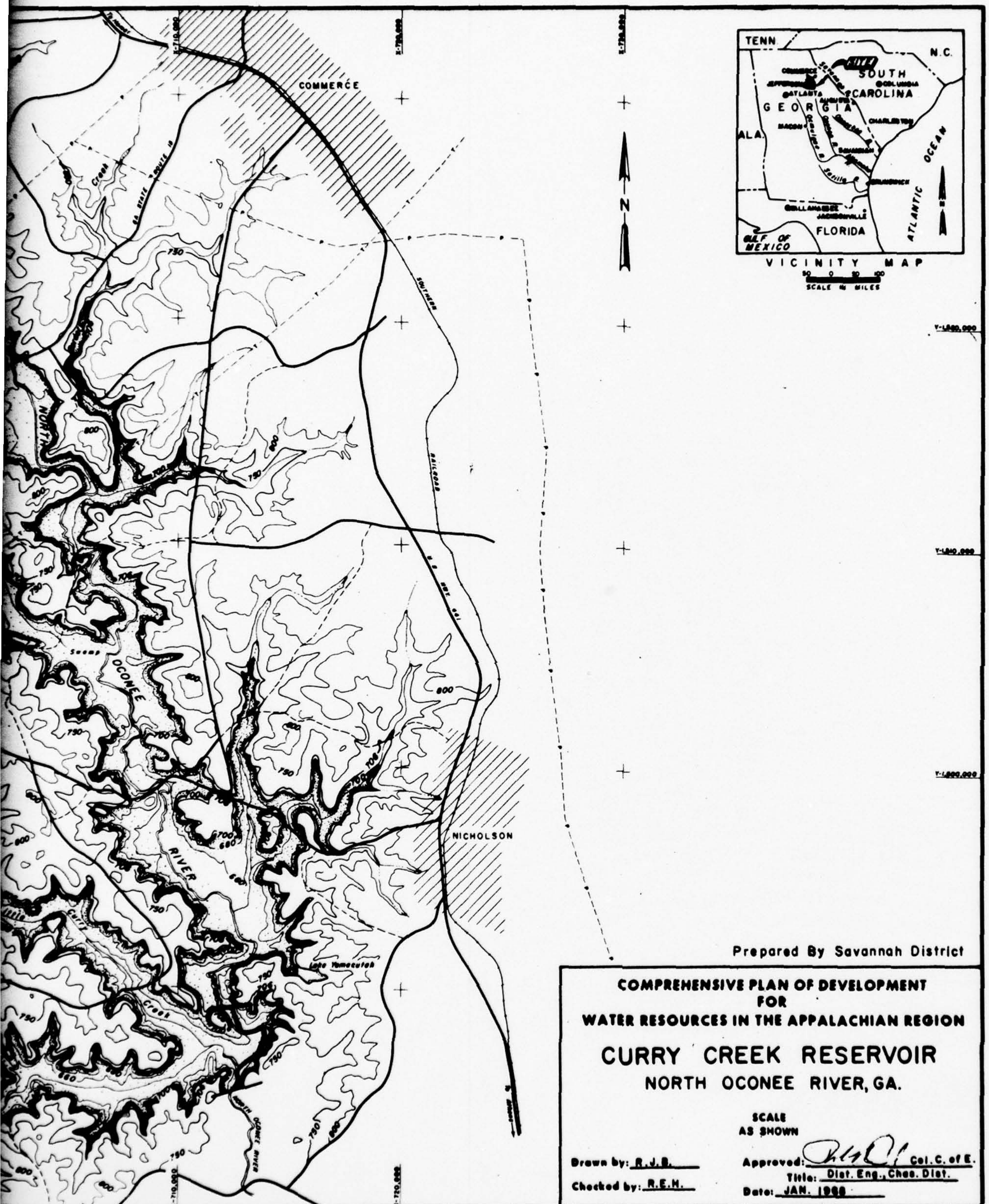

Prepared By Savannah District

**COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION**

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

SCALE
AS SHOWN

Drawn by: R.J.B.
Checked by: R.E.H.
Approved: Col. C. of E.
Title: Dist. Eng., Chas. Dist.
Date: JAN. 1968

Exhibit 7-3

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SECTION III - DESIGN CONSIDERATIONS

9. HYDROLOGIC

Analysis of hydrologic data is necessary for determination of the adequacy of the project facilities to accomplish the proposed purposes. The following paragraphs include a discussion of the general hydrology of the project area and the design criteria which establish the structural requirements of the project. These criteria, together with economic considerations, determine the project dimensions.

Climatology

The Weather Bureau of the Environmental Science Services Administration, U. S. Department of Commerce, is primarily responsible for the collection, compilation, and publication of climatological data.

The following tabulation shows temperature and precipitation data at Gainesville (near the headwaters), Commerce (near the damsite), and Athens.

	Temperature			Annual Precipitation		
Station	Record Low	Avg.	Record High	Min. (in.)	Avg. (in.)	Max. (in.)
Gainesville	-8°	59.9°	107°	23.51	54.33	82.92
Commerce	-4°	58.0°	100°	34.64	54.55	67.33
Athens	-3°	61.6°	108°	30.88	49.77	75.80

Temperature

The Upper Altamaha River Basin's climate is temperate, with warm summers and mild winters. The chief factors controlling the climate are its proximity to the Appalachian Mountain range, and the relatively high altitudes. The range between summer and winter temperatures is relatively small and the average annual temperature in the basin is 60°. Extreme weather conditions have caused average January temperatures to vary as much as 20°. This variation has occurred to the same extent in the other winter months. Average monthly temperatures range from 43.6° in January to over 79° in July. Extreme temperatures of record over the basin range from a minimum of -8° at Gainesville to a maximum of 108° at Athens. Periods during which sub-freezing temperatures are reached are infrequent and short, as are periods during which temperatures exceed 100°.

Precipitation

Precipitation in the basin is well distributed and averages about 51 inches per year. Most precipitation occurs as rainfall, and although light snow is not unusual, it constitutes a negligible portion of total precipitation. The rainfall is generally well distributed throughout the

year, but is greatest during the winter and early summer months, with about six inches in March, the wettest month. October is the driest month with about three inches. About half of all rainfall comes in amounts of one inch or more in 24 hours.

Storms - Types and Severity

The basin is subject to numerous storms due to its location in relation to the Appalachian Mountains. Storms of three types occur in the basin; thunderstorms, tropical cyclones, and frontal storms. Thunderstorms in the summer are frequent and often severe. Tropical cyclones, or hurricanes, are rare but on occasion have caused extensive damage in the basin. Storms associated with movement of frontal systems are common in the area, usually causing prolonged rainfall. This type storm is least severe since it is usually of low intensity.

Thunderstorms, which result from instability of adjacent air masses, are characterized by strong updrafts and downdrafts and rainfall of short duration and high intensity. This type of storm is usually limited to relatively small areas or narrow bands along cold fronts or squall lines. Hurricanes are intense cyclones of tropical origin and of relatively small horizontal dimensions usually less than 300 miles. Hurricanes usually occur in late summer or autumn and generate heavy and prolonged precipitation. Frontal storms, associated with the passage of frontal systems, usually cover a wide area. However, the rainfall from these storms is ordinarily less intense than that occurring during thunderstorms or storms spawned by hurricanes.

Major Experienced Storms

27-31 July 1887. This storm resulted from a West Indian hurricane. The hurricane moved northwestwardly across the Caribbean Sea into the Gulf of Mexico where it turned abruptly to the northeast, reaching the Alabama coast on the 27th. It then moved on an erratic course across Alabama into Georgia, then westward back into Alabama. The storm brought heavy rainfall to Georgia and Alabama. Union Point, Georgia, recorded 16.50 inches of rainfall, the 3-day record. Athens, Georgia, just south of the basin recorded 12.63 inches of rainfall 28-31 July.

29 September - 3 October 1929. A West Indian hurricane moved inland near Pensacola, Florida, on 30 September. It traveled northeasterly across north Florida and south Georgia. This storm was unusual in that its path carried it from the West Indies into the Gulf of Mexico, then overland to the Atlantic Coast. Athens recorded nearly 6 inches of rainfall during the 2-day period of 1 and 2 October. This storm was preceeded by heavy rainfall in the basin 22-26 September.

10-17 August 1940. This storm, which resulted from a West Indian hurricane, is of interest because of its long duration and unusual path,

even though it did not cause very high flood stages in the basin. The storm moved inland on 11 August at Beaufort, South Carolina. Following a semi-circular path, the storm moved across Georgia, through Tennessee and Kentucky and down into North Carolina, passing out to sea south of Norfolk, Virginia, on 16 August. The entire basin was covered by the 5-inch isohetal.

26-27 May 1966. This short-duration thunderstorm covered a small area and had centers of extreme intensity. The storm centered over the Athens area where the maximum daily precipitation of record occurred on 26 May. More than 9 inches of rainfall were recorded at several sites in Athens. However, the Weather Bureau station at Athens airport recorded only 2.35 inches. Georgia Power Company in Athens recorded 9.40 inches of rainfall from 10:00 p.m., 26 May to 8:00 a.m., 27 May. The heavy rains and rapidly rising streams caused considerable damage to streets, roads, bridges, and buildings in and around Athens. A similar storm occurred 26-27 June 1963.

Initial Losses and Infiltration

All soils will absorb and retain a certain amount of water within their granular structure and generally this is the most important factor in determining losses. Transpiration, evaporation, and surface retention are other sources of loss, but are relatively unimportant insofar as run-off resulting from a design storm is concerned. Since infiltration is the most important factor affecting the relationship between rainfall and runoff, it was necessary to establish a relationship between the two. The sparse runoff data available made it necessary to investigate floods which had occurred in nearby basins of similar size and topography. These investigations showed that losses due to infiltration varied from 0.08 to 0.12 inch per hour for large storms. Initial losses in this region normally range from 0.3 to 0.6 inch and is relatively small compared to the flood runoff volume. Consequently, this factor can be approximated without introducing an appreciable error. An initial loss of 0.5 inch and an infiltration index of 0.1 inch per hour were adopted for calculating the rainfall excess of the design storms.

Streamflow Records

The U. S. Geological Survey (USGS) is the governmental agency primarily responsible for the collection and compilation of surface water data. These data have been published on a yearly basis in "Surface Water Records of Georgia" since 1 October 1960, and in USGS water-supply papers prior to that date. The USGS operates five partial record stations in the basin, two low-flow stations, and three crest-stage stations. The North Oconee River gage at Athens is used as the index station in determining damages. It is the only gage studied which has a period of record exceeding 17 years. Streamflow data for the tributary areas are either non-existent or available only for the last few years.

Runoff

In the North Oconee River Basin above Athens, runoff amounts to about 20 inches annually or about 39 percent of the rainfall. The records for the gage at Athens are indicative of runoff in the area. Published records are available for an eleven-year period extending from 1929 to 1932 and from 1944 to 1950. Subsequent data accumulation has been limited to flood peak stages. The recorded extremes of runoff were a maximum of 39.09 inches and a minimum of 8.22 inches. This station, which is downstream from all flood-producing tributaries above the damsite, records runoff from a drainage area of 283 square miles. The average yearly runoff for this eleven-year period is 21.01 inches. This is equivalent to a mean annual discharge of 438 cubic feet per second (cfs). The greatest discharge of the North Oconee River at Athens occurred during the flood of May 1966, estimated to have been 15,500 cfs. This represents an instantaneous unit discharge over the basin of 55 cfs per square mile. The minimum flow of 16 cfs was observed in October 1955. Average runoff ranges from less than one inch in August to nearly three inches in March. There are no existing reservoirs in the basin above Athens that modify natural runoff patterns.

Consumptive Uses

The City of Jefferson uses water from Curry Creek for water supply. The 1960 population of Jefferson was 1,746 and at present the population is approximately 2,200. The City uses an average of 0.5 million gallons per day (mgd) and has facilities capable of supplying 0.86 mgd. No other town in the basin above the damsite uses surface water for municipal water supply.

However, the Athens water system is dependent on the flow of the North Oconee River for its water supply, and its peak demand has increased to the point that it equals the record low flow of the stream.

Ground Water

Ground water in the Piedmont area usually occurs under water table conditions. The water is stored in the overburden and in structures (fractures, joints, schistocity, etc.) in the underlying bed rock. The structure in the rock is the predominant controlling factor for the movement and storage of water. Usually the greatest number of rock fractures occur in valleys or at lower elevations. Thicker overburden is also normally found in the lower elevations. Both of these factors favor the chances of significant occurrence of ground water in the valleys. The four core borings taken at the proposed damsite suggest that the above conditions apply to the Curry Creek Reservoir area. The proposed reservoir is underlain primarily by biotite gneiss; the extreme upper reaches are underlain by granite gneiss. Both of these rock types are usually considered poor ground-water aquifers. The core borings encountered water in rock below the soil. Because of the poor chances for substantial

ground water supplies, most or all of the communities in the area use surface water. Ground water is mainly used as a water supply source by rural inhabitants. Dug wells, usually constructed in low areas near streams, and drilled wells, usually construed on slopes and higher elevations, are used as water supply sources.

Possible Effect of Project on Ground Water

Any rise in the water table attributable to the proposed reservoir would probably have a beneficial effect on drilled wells surrounding the reservoir. It is possible that a rise in the water table could have an adverse effect on an occasional dug well by causing it to cave in, but very few wells of this type will exist around the reservoir rim after it is filled. Underseepage in rock beneath the dam could possibly cause springs, wet spots, and swampy conditions downstream unless a positive cut-off is constructed. This appears to be especially true in the right abutment where core boring No. 3 encountered a pegmatite overlaying granite (See boring log, paragraph 10, and location, Exhibit 7-2).

Proposed Improvements and Their Effect on Flow Regimen

As part of the Appalachian Water Resource Survey, the U. S. Department of Agriculture has proposed an Upstream Watershed Project including nine small floodwater retarding structures, channel improvement, and an accelerated program of land treatment measures in the upper North Oconee River basin above the Curry Creek Damsite. Information on this proposed project and program can be found in the "North Oconee River Watershed Investigation Report" and Appendix A published by USDA. Based on preliminary information, this project and program will provide useful supplements to the benefits arising from the Curry Creek Project.

Flood Characteristics

Floods in the North Oconee River Basin usually peak rapidly and are of short duration. Flood waters recede to bankfull stage quickly, usually within 72 hours. Winter and spring are the seasons of greatest flood activity, although damaging floods have occurred in the fall and summer. Generally, the major floods are preceded by an extended period of moderate precipitation which saturates the soil and creates conditions which cause high amounts of runoff from subsequent rainfall. In the tributary watersheds, streams rise from their base flows to flood stages in but a few hours, remain at crest stage for only a few hours, and usually return to base flow in 1 to 3 days. The travel time of the flood wave in the North Oconee River is primarily influenced by the direction of the storm path and the location of the area over which it centered.

Storage Allocations

Curry Creek Reservoir, located on North Oconee River about 12 miles north of Athens, has been designed as a multi-purpose project to provide flood protection at Athens and for the intervening valley, water supply for present and future needs, and to provide an area for water-oriented recreation. Storage has been allocated to accomplish each of these

purposes and to allow for sediment deposition. Total controlled storage is 180,000 acre feet below elevation 706. The specific allocations, in acre feet, are as follows: sediment, 14,000; conservation, 127,000; and flood control, 39,000. The bases for these allocations are discussed in the following paragraphs.

Sediment

The average rate of sediment production in the Piedmont area is about 0.75 acre foot per year per square mile of drainage area. This indicates that for the 100-year life of the project it would be necessary to provide about 13,575 acre feet for sediment. Sediment storage below elevation 661 allows 14,000 acre feet.

Conservation

Storage between elevations 661 and 700 is reserved for conservation. This amounts to 127,000 acre feet. Water supply for the Cities of Athens, Jefferson and Commerce and the other population shown in Table 7-1 would be furnished from this storage. Total storage up to elevation 700 is 141,000 acre feet.

Water Supply and Water Quality Control

An evaluation of water supply and water quality control needs for the Curry Creek Project has been performed by the FWPCA (See Appendix D). In their 50-year evaluation, FWPCA stated that no water quality control storage was needed in Curry Creek Reservoir to augment flow in North Oconee River through Athens. Therefore, no storage has been allocated for water quality purposes.

The councils of the Cities of Athens and Jefferson have furnished copies of resolutions requesting the Federal Government to allocate conservation storage for water supply for their use. The State of Georgia has expressed its interest in purchase of the unreserved portion of the water supply storage. The resolutions are reproduced in Section VII of this Chapter. A storage of 27,000 acre feet of the conservation storage has been allocated to water supply. This amount of storage will yield a firm supply of 60 mgd, the estimated water supply needs in the year 2020 (See Table 7-1). This will provide Athens 35 mgd, Jefferson 2 mgd, and an unreserved supply of 23 mgd.

No record of flow exists for the North Oconee River at the Curry Creek damsite; therefore, it was necessary to estimate flows at this site. Estimates of flows were made by correlation with a station having records for the desired time. These flows were adjusted on the basis of tributary area and other hydrologic factors. The gage station on the Middle Oconee River was selected as the station having the most reliable and applicable record for the critical period. The critical

period for the Curry Creek project was determined as the period in a sequential record which would have required the largest volume from storage to provide the specified yield. The critical period was taken as the time from beginning of storage utilization to the time that the conservation pool refills during the period when the reservoir is drawn down to its lowest level. Based on the sequential mass curve, this period was determined to be March 1954 to December 1955 which has a frequency of once every fifty years. Exhibit 7-4 shows the dependable yield available from various volumes of conservation storage.

Water will be pumped directly from the reservoir for the systems around and upstream of the reservoir. Water supply from the reservoir for systems downstream of the dam will be released and allowed to follow natural streambeds to water system intakes. These flows will be adequate to maintain satisfactory conditions in the channel and streamside areas between the dam and the site of the principal diversion, considered to be the waterworks pumping plant near the upstream limits of the City of Athens. However, below this diversion point conditions could develop, due to the influx of deleterious materials from storm sewer outfalls, sewerage treatment plants, and other sources, which would necessitate periodic flow augmentation to maintain the assimilative capacity of the North Oconee River at least as far as the confluence with the Middle Oconee River. In order to avoid this contingency, a more detailed analysis will be made during post authorization studies. Should a need for pollution abatement measures be found, the cost of providing for water quality storage vs. that of extending storm and/or other sewer outfalls will be evaluated.

Recreation

The conservation pool (surface elevation 700) will be used for recreation. The drawdown caused by withdrawals to satisfy the water supply needs during the initial period of reservoir operation could be about two feet for a normal low-flow period. However, withdrawals to satisfy the ultimate water supply needs, involving the entire water supply storage of 27,000 acre feet, may result in a maximum drawdown of 5 feet. Although this drawdown is not desirable, interference with recreation usage is not expected to seriously affect this purpose except during very rare drought occurrences.

Flood Control

The flood control storage between elevations 700 and 706 amounts to about 39,000 acre feet. This volume will provide storage for four inches of runoff from the drainage area above the damsite. This flood control storage will completely store the runoff from the 100-year frequency flood. Total storage in the reservoir up to elevation 706 is 180,000 acre feet.

Area and Capacity

The area and capacity curves for the Curry Creek Reservoir were determined from 1964, 7.5', USGS quadrangle sheets. The contours were planimetered and their areas computed. Electronic computer techniques were used to derive an area curve fitting the contour areas, to calculate areas at one-tenth of a foot intervals, to obtain capacities at the same interval by using the double end area method, and to print out the tabulated area-capacity values. The area and capacity curves are shown on Exhibit 7-5.

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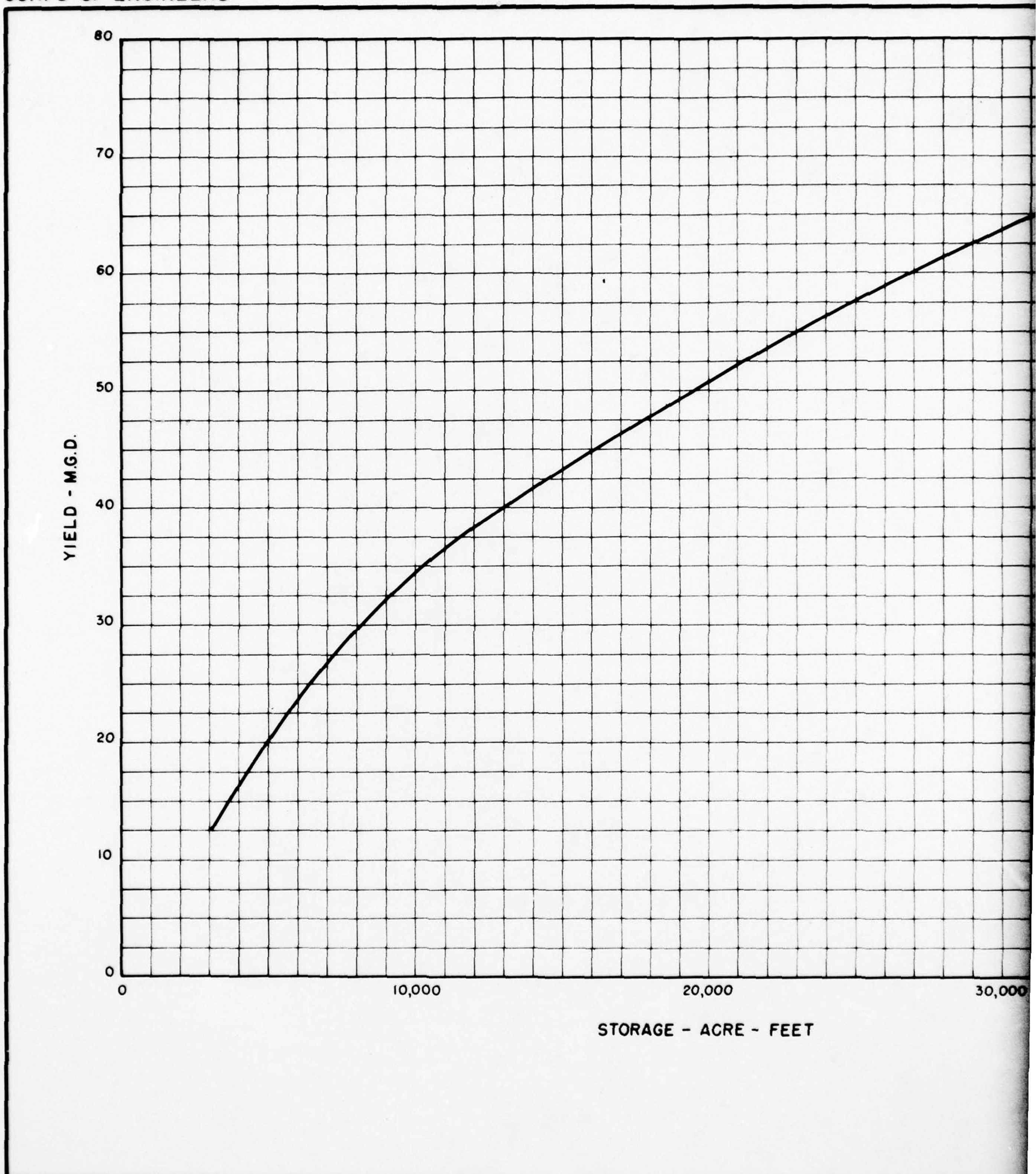

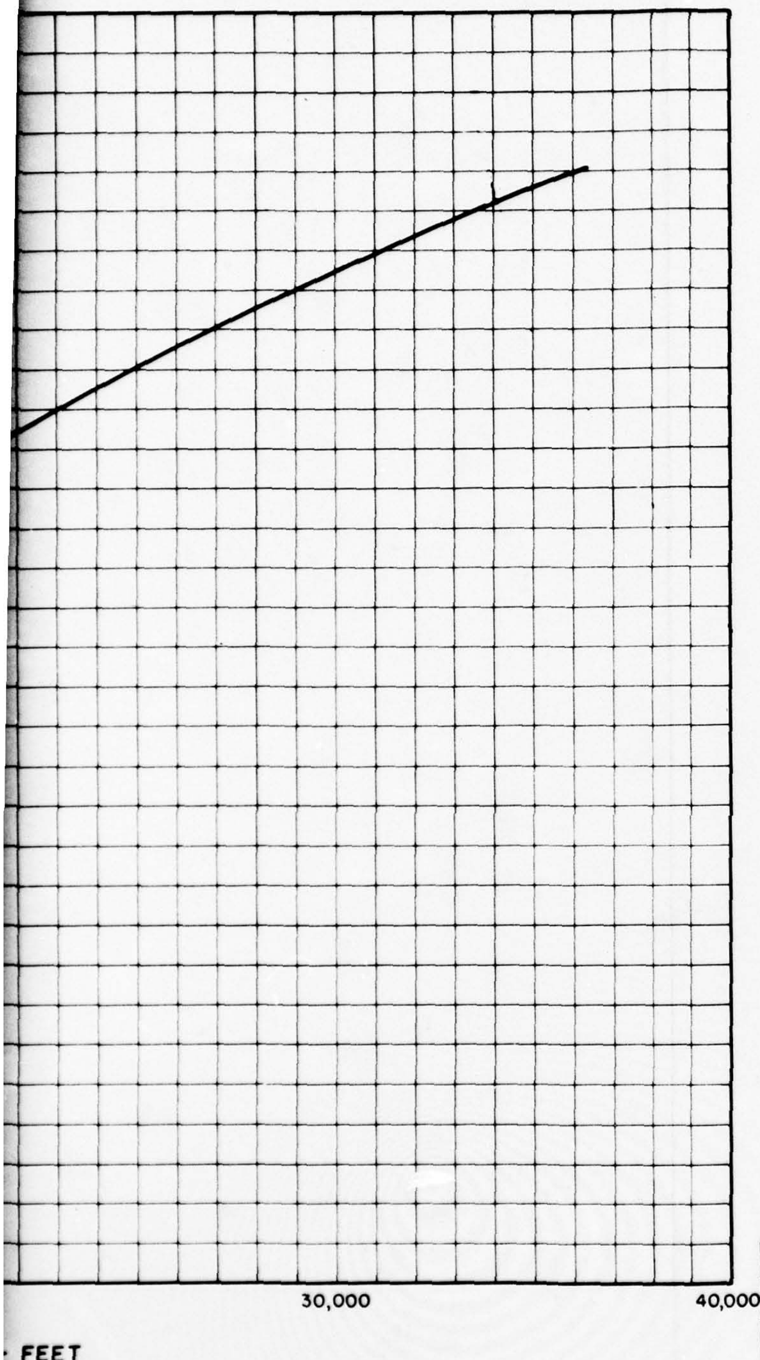

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

STORAGE-YIELD CURVE

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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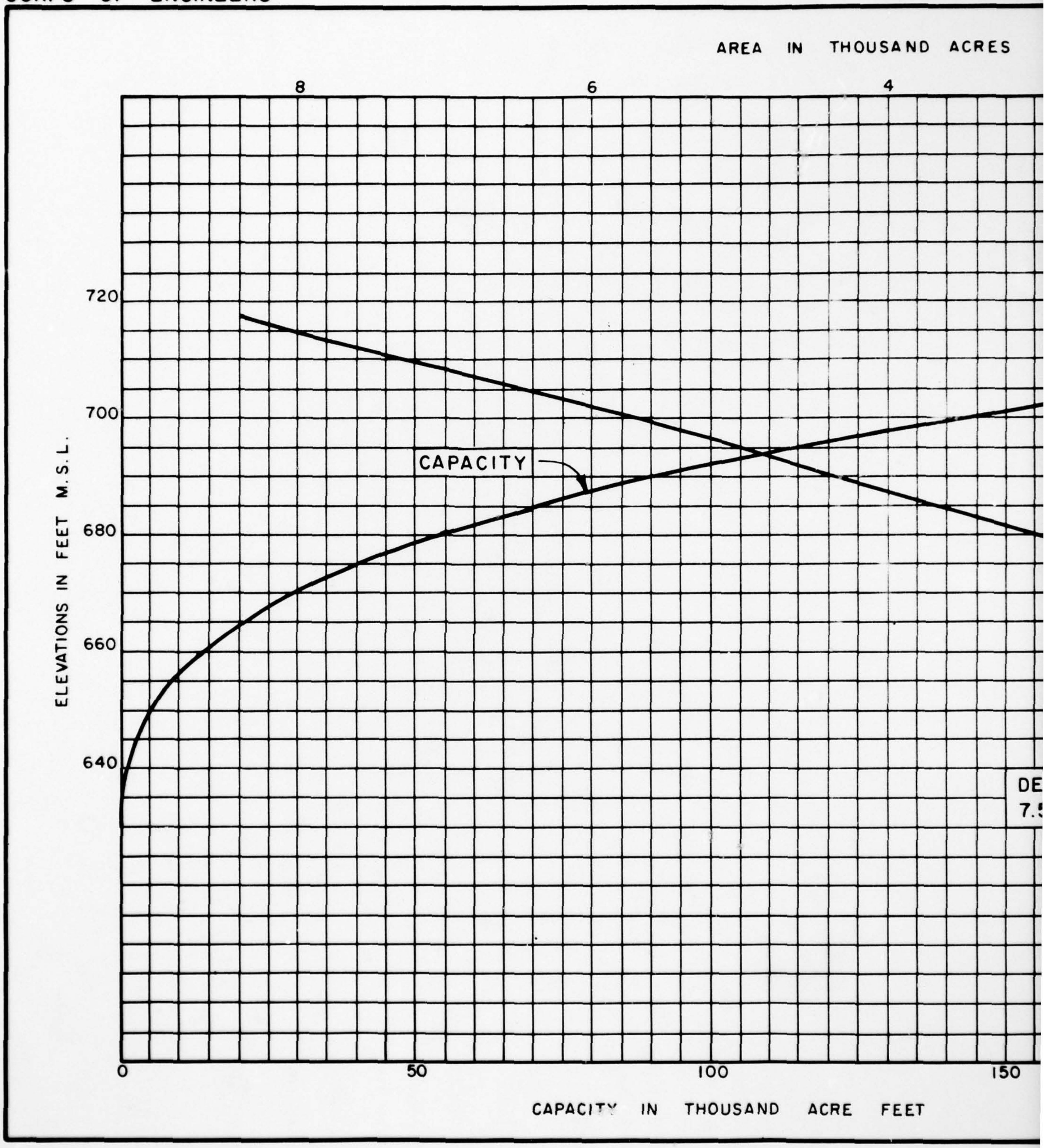

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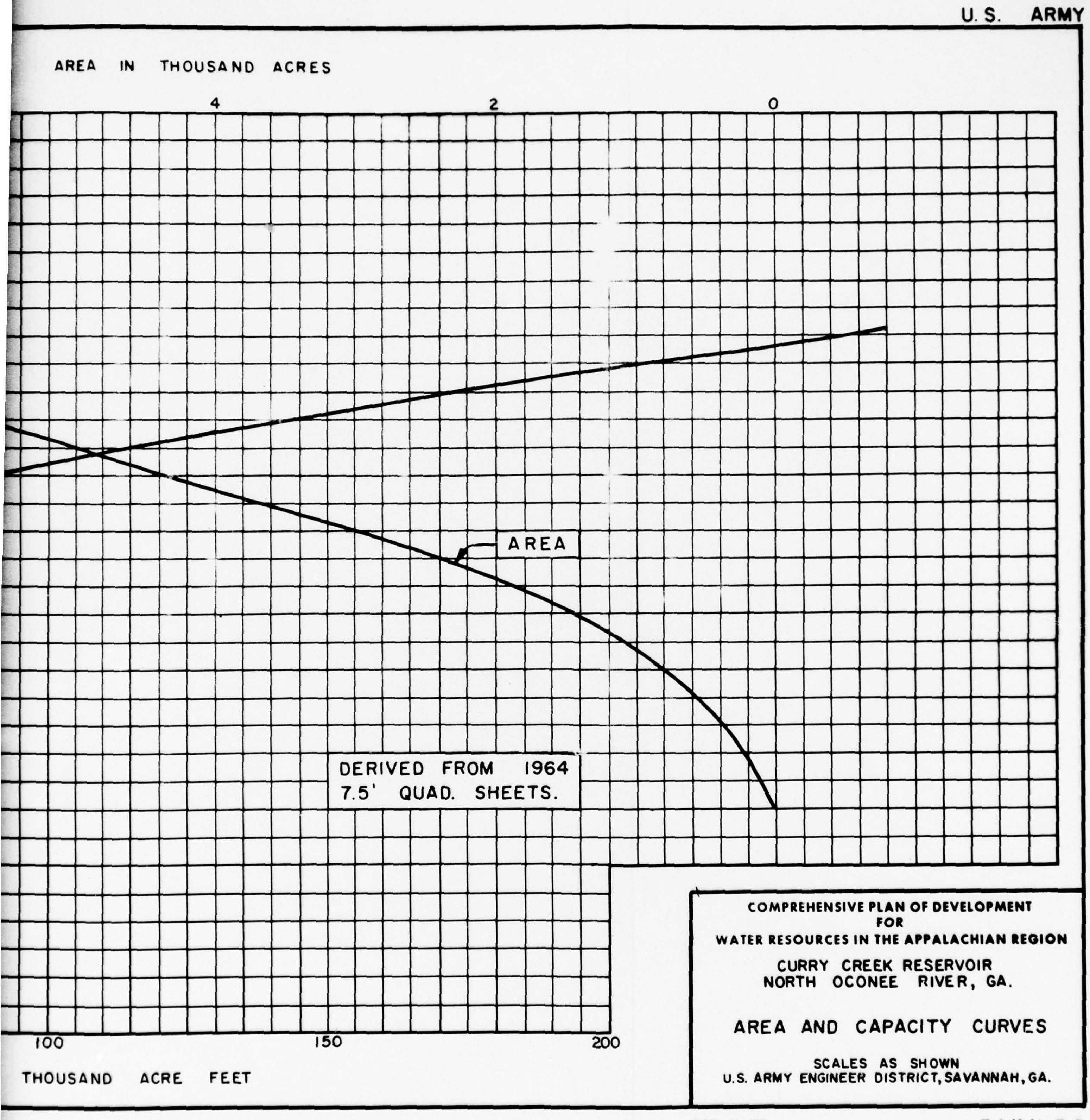

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

AREA AND CAPACITY CURVES

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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Flood Analyses and Unit Hydrograph Determinations

Sufficient data to determine natural unit graphs for the Curry Creek damsite and damage index station at Athens were not available. Consequently, empirical methods were used. The Chestatee River at Dahlonega, Georgia, unit graphs, taken from the Definite Project Report on Buford Dam, Appendix VI (Hydrology), charts numbers 145 and 233, were used to derive unit graphs for the Curry Creek Project Basin. These unit graphs were selected because of topographic and drainage area similarity of the basins. The natural unit graph derivations for Dahlonega are presented on Exhibit 7-6. Unit graphs derived from ordinary floods often give peak discharges considerably less than those that might be expected when applied to storms of the standard project and spillway design magnitude. This inability to correlate the natural unit graphs to large storms has several causes. The velocity of small tributaries increases with an increase in surface runoff, shortening concentration time, reducing storage effect, and causing higher peak discharges. The difference in areal distribution of rainfall is greater in large storm runoff, particularly if the storm is concentrated in the lower part of the basin. The unit graph developed for the Curry Creek damsite gave standard project and spillway design floods with peaks considerably lower than expected. Therefore, unit graphs with peak discharges 50 percent higher than those of the natural unit graphs were derived. The steps involved in this adjustment are given in EM 1110-2-1405, "Flood Hydrograph Analyses and Computations", dated 31 August 1959. This percentage of increase of peak flow is considered adequate to reflect the accelerated velocities and accentuated peaks from high intensity rainfall of either design storm. Exhibits 7-7 and 7-8 show the derived unit graphs and the adjusted unit graphs used to determine the design floods for the damsite and reservoir. Table 7-2 gives a comparison of Snyder coefficients for the Chestatee River, the damsite, and the damage index station. The damage index station unit graphs were derived and adjusted in the same manner as those for the damsite and reservoir.

Natural Runoff Conditions

Topographic characteristics in the basin are conducive to a rapid runoff rate. Runoff from the upper reaches of the basin usually reach the gaging station at Athens within 12 hours. Extensive runoff data are not available in the basin, but studies in adjacent basins indicate runoff averages about 39 percent of the annual rainfall. In the upper portion of the basin, runoff amounts to as much as 50 percent of the rainfall. Except for a few swampy areas, which are small, the stream channels are steep and narrow.

Runoff into Full Reservoir

The discharge hydrograph at the damsite does not accurately reflect runoff into a full reservoir since runoff into the reservoir

will have an immediate effect on the potential discharge at the damsite. Because of this, it was necessary to adjust the adopted unit graph at the damsite to reflect this full reservoir condition. A synthetic inflow unit graph was determined and is shown on Exhibit 7-8. This unit hydrograph is for the land area and does not include the reservoir surface.

TABLE 7-2
COMPARISON OF SNYDER COEFFICIENTS FOR UNIT HYDROGRAPHS

Factor Symbol	Chestatee R. 3-Hour Unit Hydrograph Coefficients	Curry Creek Dam Site: 3-Hour Unit Hydrograph Coefficients	Athens Index Station: 3-Hour Unit Hydrograph Coefficients
Drainage area (sq. mi.)	152	181	283
L (miles)	22	38.2	53
L_{ca} (miles)	12	17.5	22.3
(LL_{ca}) 0.3	5.4	7.1	8.3
t_R (hours)	3	3	3
t_{PR} (hours)	12	9.6	17
Time of peak (hours)	6	11.1	19
C_t	2.2	1.8	2.1
C_p	.55	.45	.70
q_{PR} (cfs/sq.m.)	28.6	30.0	26.5
Q_{PR} (cfs)	4,350	5,430	7,500
W_{50} (hours)	13	17.5	21
W_{75} (hours)	7	10	12.5
T (hours)	63	50	60

Standard Project Flood

The standard project flood represents a flood that would rarely be exceeded. The most severe flood-producing rainfall depth-area-duration relationship and isohyetal pattern of any storm considered reasonably characteristic of the region is used in determining the size of this storm. Standard project flood determinations were made in accordance with Engineer Bulletin No. 52-8, "Standard Project Flood Determination". The rainfall for the standard project flood has a volume equivalent to 15.69 inches and a rainfall-excess of 10.89 inches. An initial loss of 0.5 inch and an infiltration loss rate of 0.1 inch per hour was assumed for this storm. The rainfall excess, when applied to the inflow unit hydrograph, gives a standard project flood with a peak discharge of 66,000 cfs. This discharge assumes a base flow of one cfs per square mile of drainage area,

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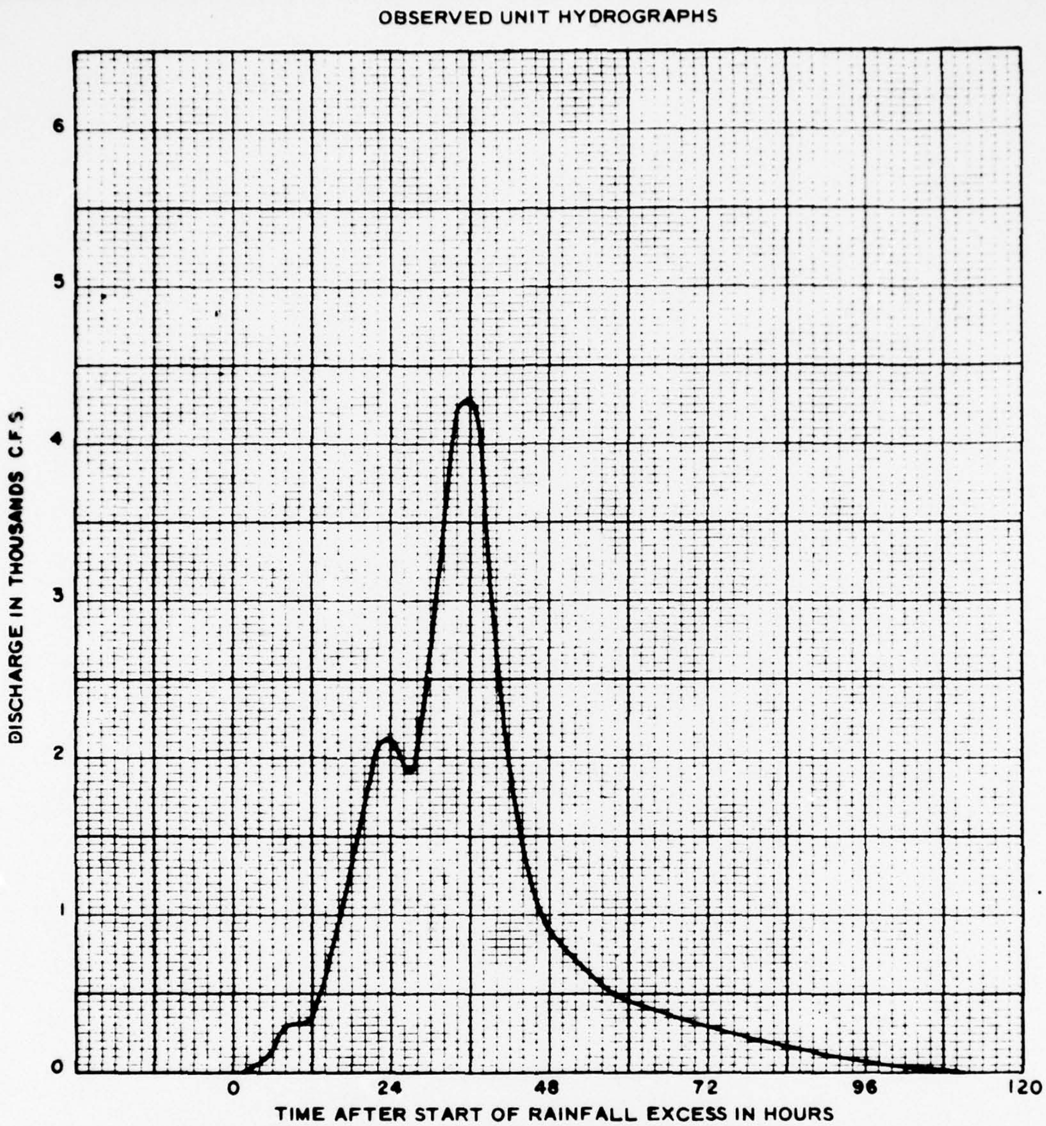

DRAINAGE AREA
MAXIMUM ELEVATION
MINIMUM ELEVATION
MEAN ELEVATION (wei
LAND SLOPE
MAIN STREAM SLOPE

DATA FROM OBSERVED UNIT HYDROGRAPHS

DATE OF RAINFALL	LEGEND	AVE. P (in.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (in.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (c.f.s.)	Q_p t_r = 36 hrs. (c.f.s.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_p
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(1
5-8 JAN 1946	———	7.34	36	3.39	UNI-FORM	Rec.	4340	6200	12	4 5	10	2 2	3

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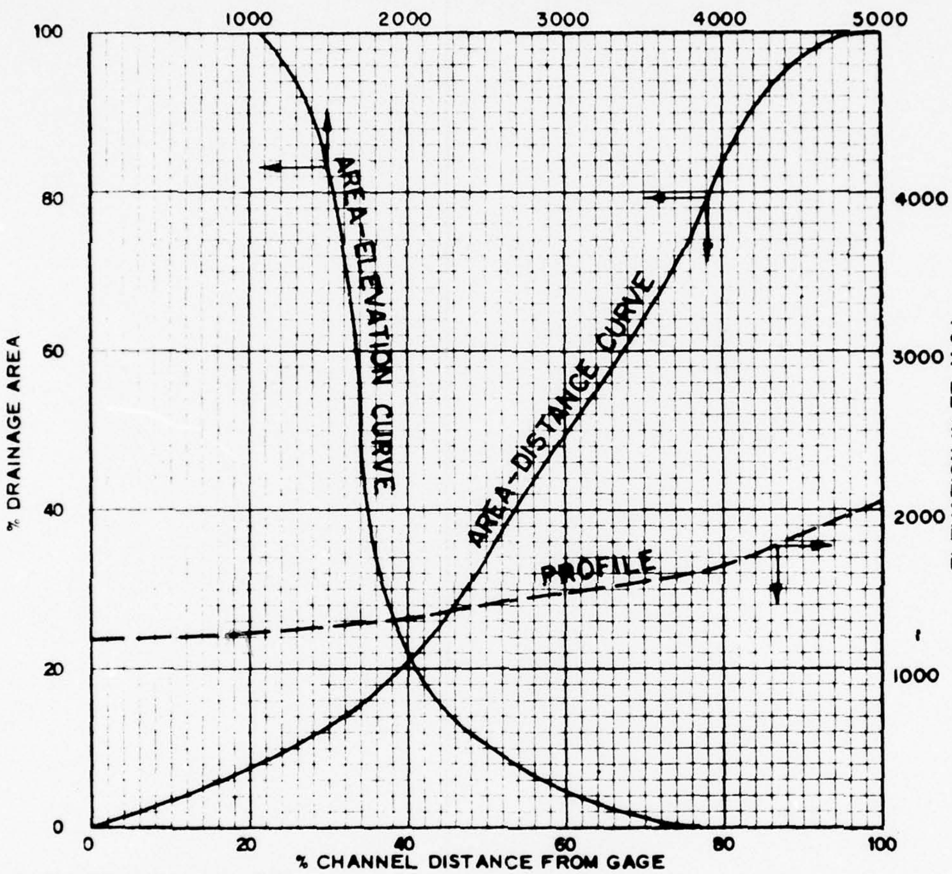
DRAINAGE AREA CHARACTERISTICS			
DRAINAGE AREA	152 sq. mi.	L	22 mi.
MAXIMUM ELEVATION	4460 ft. m.s.l.	L_{ca}	12 mi.
MINIMUM ELEVATION	1130 ft. m.s.l.	$(LL_{ca})^{0.3}$	5.4
MEAN ELEVATION (weighted)	1850 ft. m.s.l.	DRAINAGE DENSITY	— mi./sq. mi.
LAND SLOPE	— ft./mi.	MAP SCALE 1:125,000	
MAIN STREAM SLOPE	23.5 ft./mi.	METHOD OF FLOW SEPARATION	TYPE C
		BASIN SHAPE FACTOR	5.8



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RAPHS

Q_p t_r = 36 hrs. (c.f.s.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_p640	K_m (hr.)	T_c (hr.)
(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
6200	12	4 5	10	2 2	343	5.7	8

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

UNIT HYDROGRAPH
PERTINENT DATA
CHESTATEE RIVER AT DAHLONEGA, GA.

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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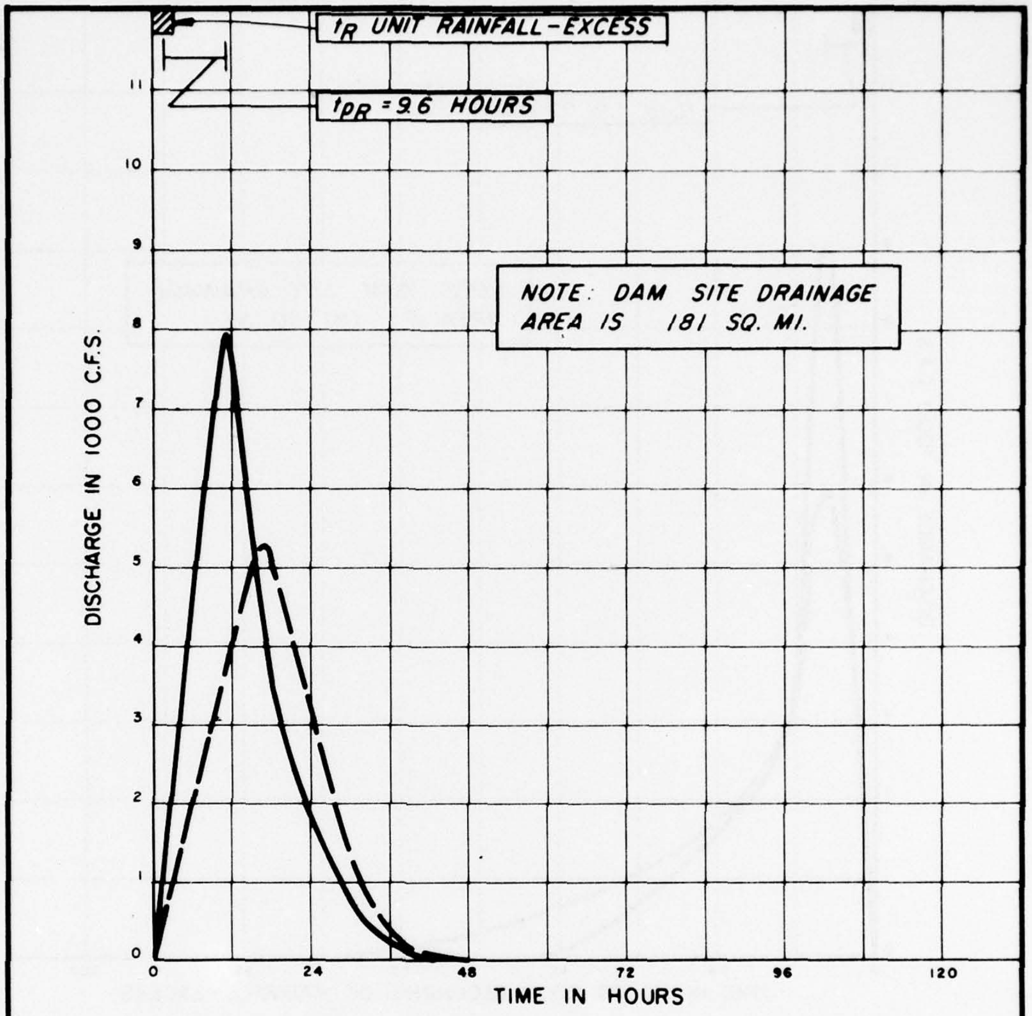
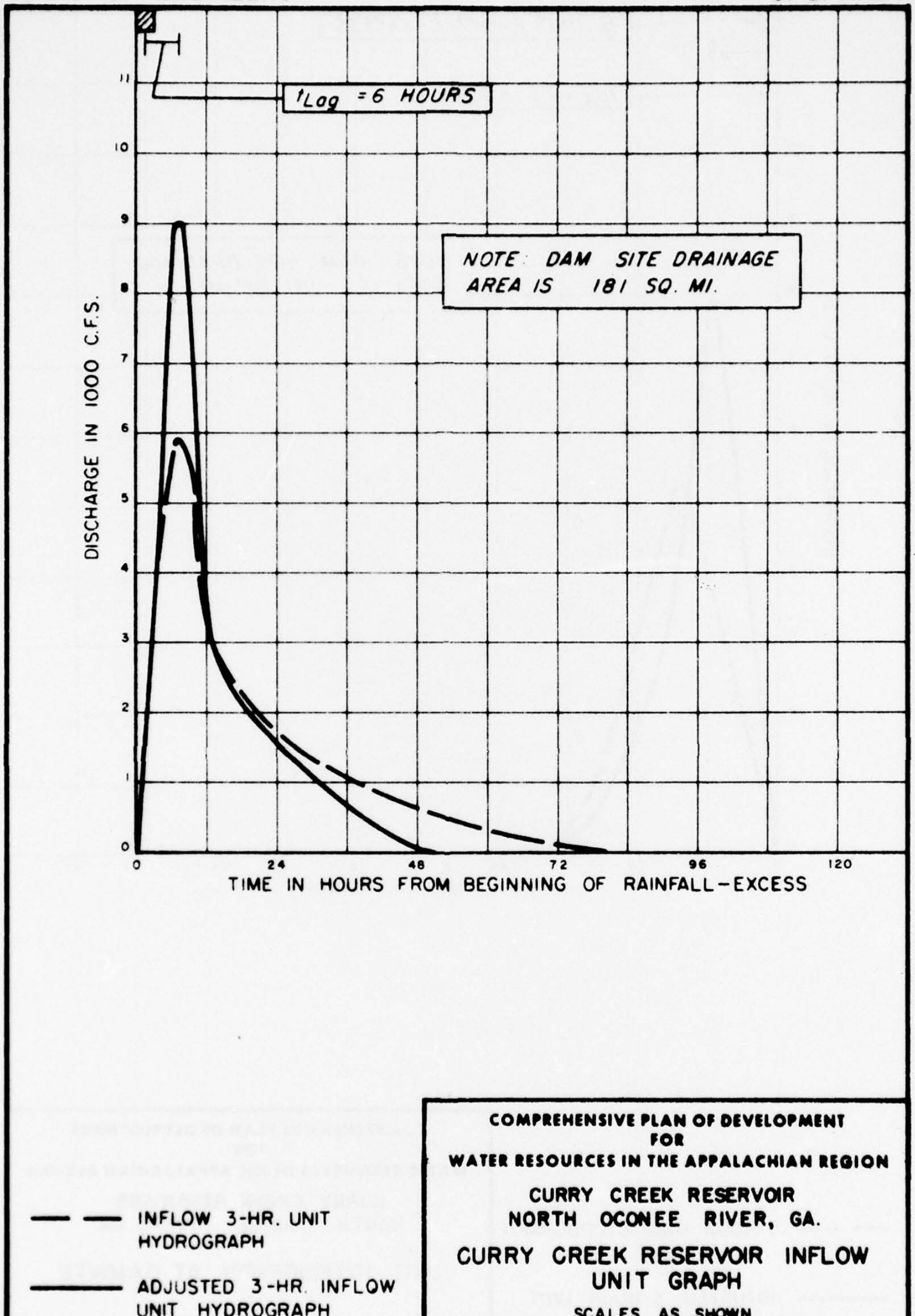


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

UNIT HYDROGRAPH AT DAMSITE

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

CURRY CREEK RESERVOIR INFLOW UNIT GRAPH

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

Exhibit 7-8

which is 181 square miles. In order to determine flow reductions at the Athens damage index station, a standard project flood was also determined at that site. The total rainfall for this standard project flood is 15.26 inches, with 10.43 inches of rainfall-excess. Losses assumed were the same as those for the standard project storm at the damsite. The rainfall-excess was then applied to the unit hydrograph at the index station to determine the standard project flood. A peak discharge of 95,000 cfs was obtained. Table 7-3 presents a summary of standard project flood data at the damsite and index station.

Recommended Spillway

Several different types and sizes of spillways were investigated. A free-overflow type of spillway in a saddle proved to be nonfeasible because of the elevation of bed rock and extreme quantties of excavation. A gated spillway in the existing channel valley was chosen. A spillway with 3-30' x 25' gates kept the surcharge pool, gate size and stilling basin within reasonable limits.

Induced Surcharge Envelope Curve for Gated Spillway

For a gated spillway, the reservoir regulation is limited by the induced surcharge envelope curve. This curve represents the maximum reservoir level and rates of spillway discharge under indicated flood conditions when operating under the induced surcharge plan. The adopted induced surcharge envelope curve was constructed to limit the maximum pool under induced surcharge operating conditions to elevation 711 before gates are fully opened. This elevation is five feet above the top of flood control pool. Also, 2,500 cfs would be discharged before surcharge is allowed. The discharge characteristics for the gated spillway are shown in Exhibit 7-9.

Tailwater Rating Curve

The tailwater rating curve is for conditions at the point of discharge of the spillway and outlet works into the natural channel of the stream immediately below the dam. As no gage exists in the vicinity of the dam, a cross-section was taken at the damsite and a rating curve was determined by use of Manning's Formula, $Q = (1.486/n)AR^{2/3}S^{1/2}$, for "n" values of .035 for channel and .070 for overbank. The tailwater rating curve is shown on Exhibit 7-10.

Spillway Design Flood

The spillway design flood hydrograph at the Curry Creek damsite was based on the runoff from the precipitation resulting from the most adverse meteorological conditions considered probable. Generalized charts developed by the U.S. Weather Bureau in Hydrometeorological Report No. 33, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square

Miles and Durations of 6, 12, 24, and 48 Hours", were used. The probable maximum precipitation adopted was based on the all season generalized data in Report No. 33. The spillway design storm at the damsite has a volume which is equivalent to 29.32 inches of rainfall and 25.82 inches of runoff from the drainage area. Rainfall-excess amounts for the storm were determined by assuming an initial loss of 0.50 inch and a uniform loss rate due to infiltration of 0.1 inch per hour. The 25.82 inches of rainfall-excess was applied to the Curry Creek Reservoir unit hydrograph to derive the spillway design flood. A base flow of one cfs per square mile of drainage area was assumed. The spillway design flood gives a peak reservoir inflow of 165,000 cfs. A flood of the spillway design flood magnitude was also determined at the Athens damage index station by the same procedure. The spillway design storm at this site has a volume equal to 27.97 inches of rainfall. The rainfall-excess resulting from this rainfall is 23.83, assuming the loss values shown above. When this rainfall-excess was applied to the unit hydrograph at the damage index site, a peak discharge of 224,200 cfs resulted. Data on the spillway design flood are summarized in Table 7-3.

TABLE 7-3
STORM AND FLOOD SUMMARY
CURRY CREEK RESERVOIR

Location	Drainage Area (sq mi)	Rainfall (in.)	Losses (in.)	Rainfall Excess (in.)	Peak Inflow into Reservoir (cfs)	Regulated Peak Discharge (cfs)	Peak Reduction (cfs)	Max. Res. level (ft.msl)
		STANDARD PROJECT STORM			FLOOD			
Damsite	181	15.69	4.80	10.89	66,000	43,000	23,000	711.0
Index Station	283	15.26	4.83	10.43	95,000*	65,000	30,000	--
				SPILLWAY DESIGN				
Damsite	181	29.32	3.50	25.82	165,000	86,000	79,000	719.0
Index Station	283	27.97	4.14	23.83	224,200*	122,000	102,200	--

*natural peak flow

Flood Routing Conditions and Results

Since it was assumed that critical storage conditions may exist at the beginning of the spillway design flood, elevation 706.0, top

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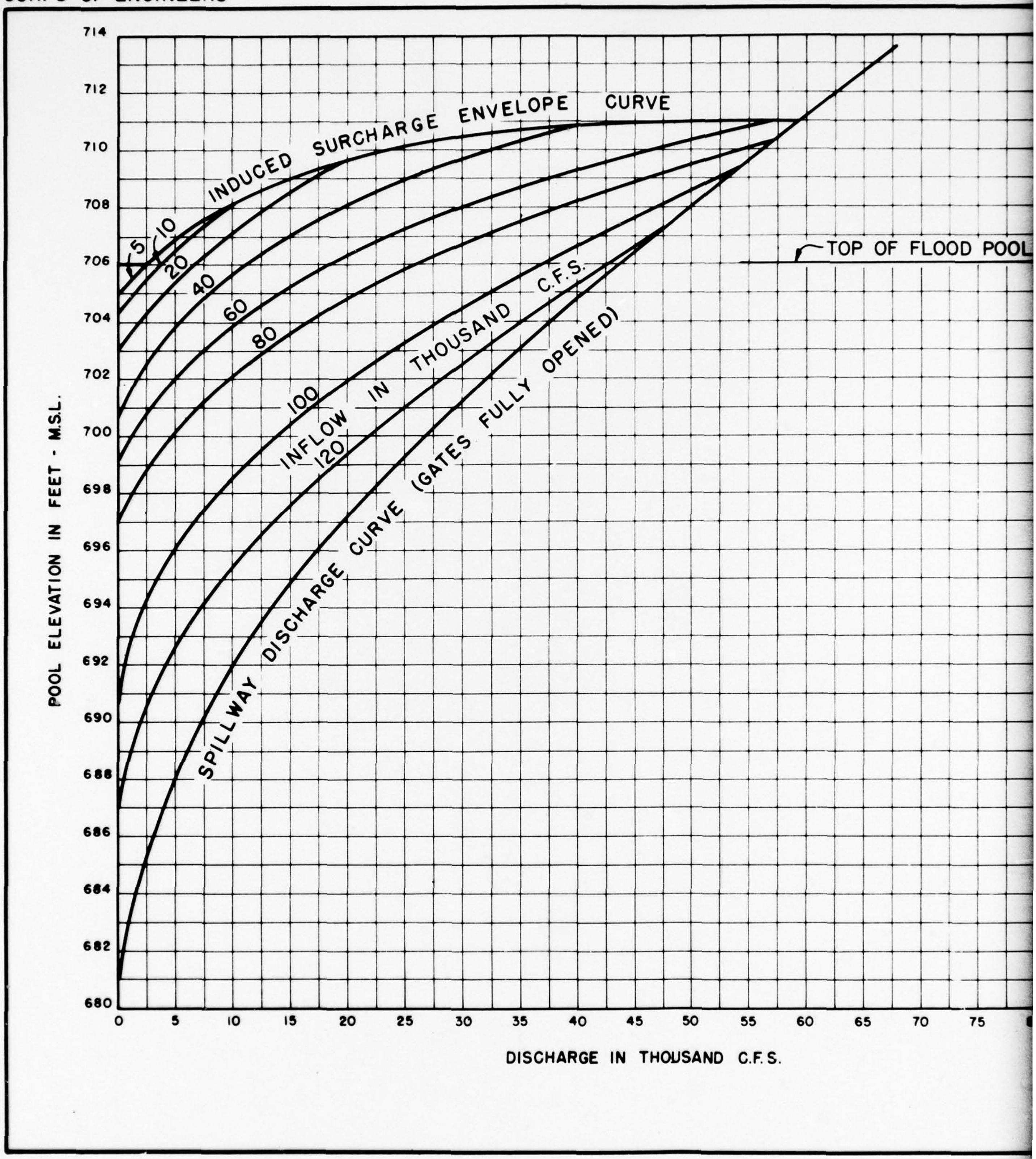

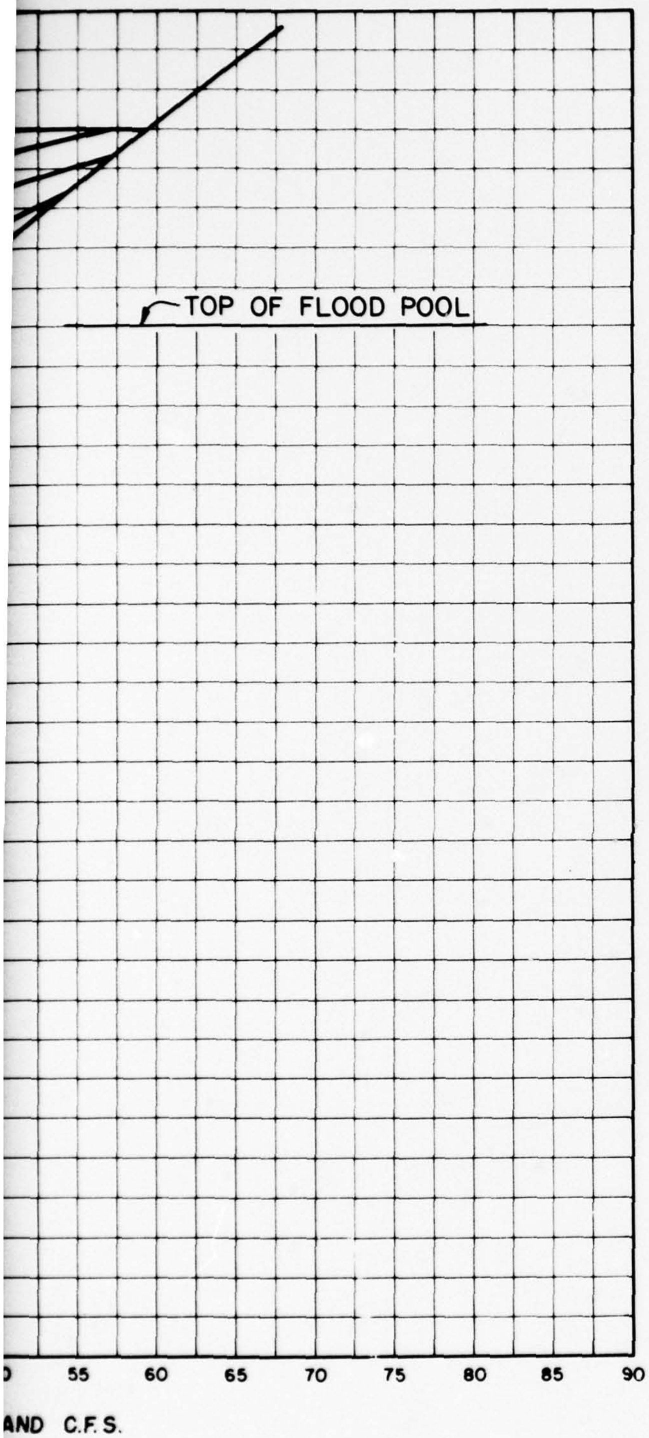

NOTES:

1. EFFECTIVE LENGTH = 90 FEET.
2. SPILLWAY CREST AT EL. 681.
3. 5 FEET OF SURCHARGE USED.
4. 2500 C.F.S. WILL BE RELEASED BEFORE ANY SURCHARGE IS ALLOWED.

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

GATED SPILLWAY
DISCHARGE CHARACTERISTICS

SCALES AS SHOWN
U. S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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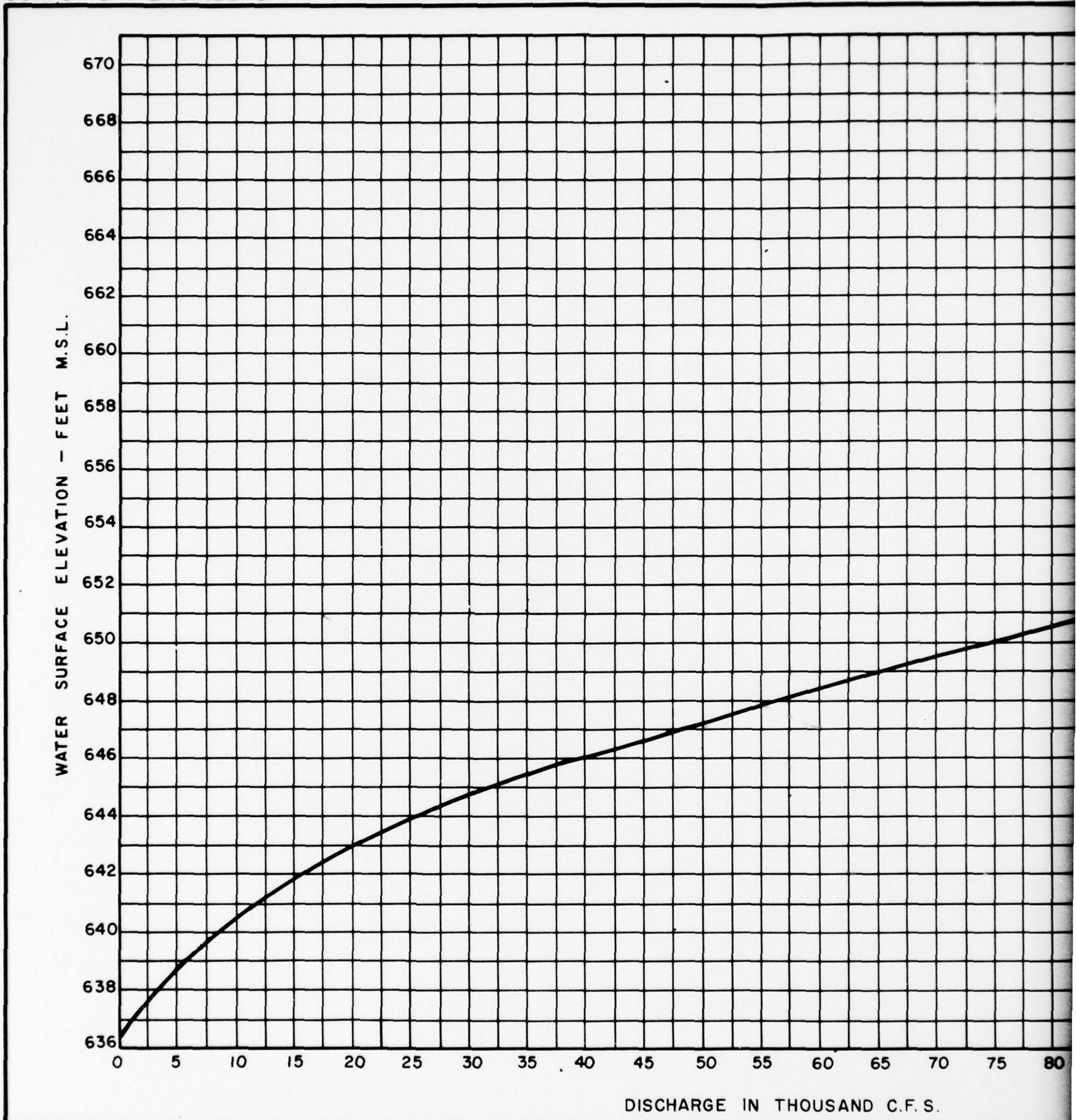

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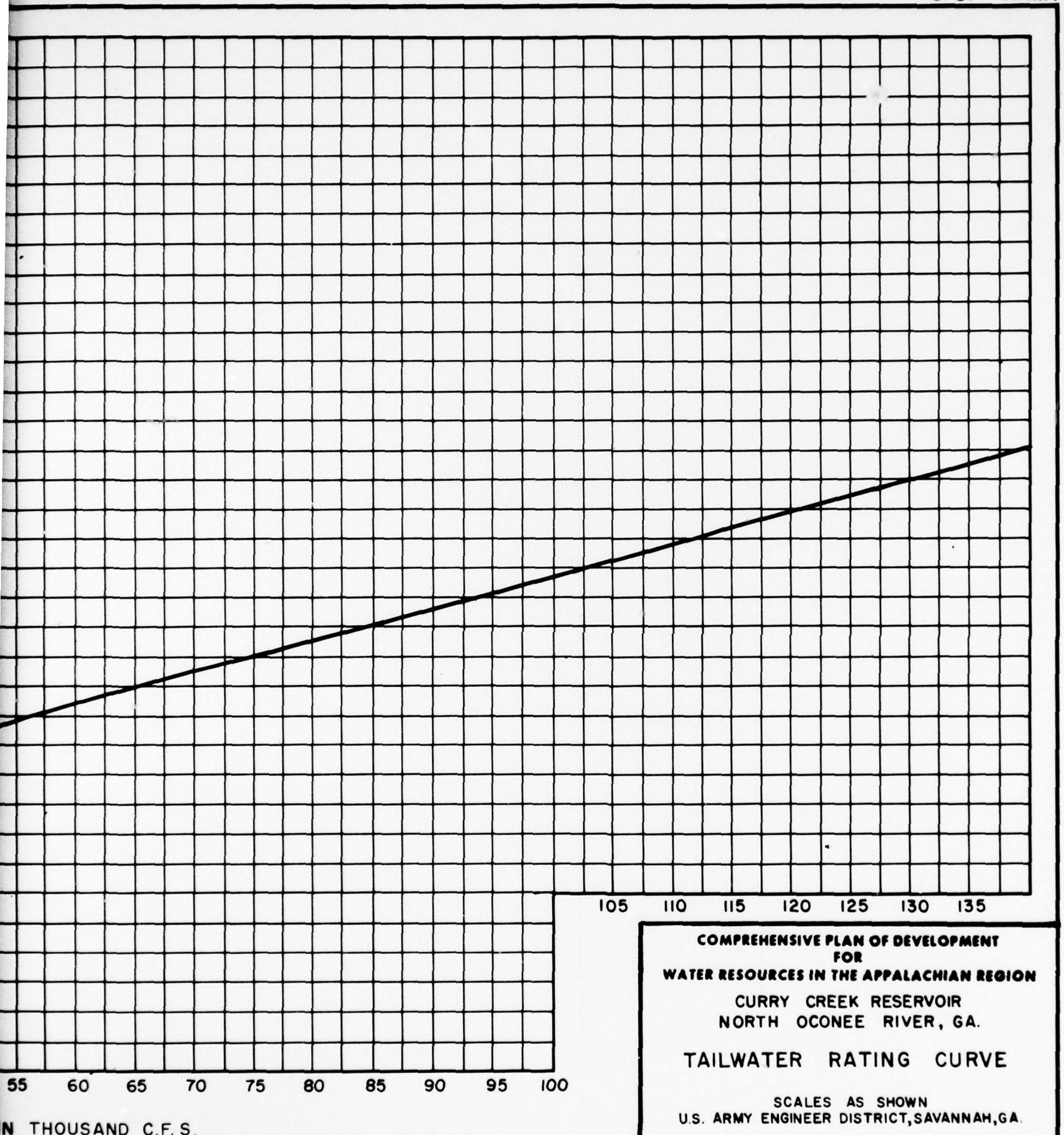

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

TAILWATER RATING CURVE

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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of flood control pool, was selected for beginning the flood routing. At this storage, the outflow would be regulated by the spillway gates which would be raised simultaneously by increments sufficient to discharge the permissible rates. The excess of inflow would be held in surcharge storage. The outflow would be governed by the spillway gate regulation schedule.

The spillway design flood hydrograph, outflow hydrograph, and pool elevation curve are shown on Exhibit 7-11.

Routing of the standard project flood through the gated spillway was accomplished in accordance with the spillway gate regulation schedule. This flood would be routed through the reservoir beginning at elevation 700 (top of conservation pool) and would reach a maximum pool elevation of 711.0. The standard project flood hydrograph, outflow hydrograph, and pool elevation curve are shown on Exhibit 7-12.

It was assumed that the low-flow sluices would be inoperative during the floods. Even though this may be an extraordinary precaution, its possibility must be considered, especially in routing the spillway design flood.

Freeboard

A freeboard allowance for the dam was computed in accordance with the criteria published in Engineer Technical Letter No. 1110-2-8, "Computation of Freeboard Allowance for Waves in Reservoir", dated 1 August 1966. The effective fetch for the Curry Creek Reservoir was computed to be 0.3 mile. The wave-tide fetch was 2.0 miles, and the average reservoir depth was 55 feet. Freeboard computations were based on an average wind velocity over land of 60 mph, equivalent to 78 mph over water. The freeboard was computed to be approximately five feet.

Top of Dam

The top of the dam is set at elevation 724.0, which provides for the maximum water surface attained by routing the spillway design flood through the reservoir, plus an adopted freeboard of 5.0 feet. The spillway design flood would reach a pool elevation of 719.0, with a peak inflow of 165,000 cfs.

Reservoir Regulation Plan

During low flow periods minimum downstream requirements up to 58 mgd can be released from the reservoir. The reservoir releases should provide the instantaneous minimum flows at Athens equal to the 7 day low flow occurring once in 10 years except during periods when the inflow to reservoir is less, at which time the minimum flow at Athens will be equal to the reservoir inflow. During normal operation the reservoir will be operated to maintain a recreation pool at elevation

700 feet msl providing the discharge from the dam does not exceed bankfull stage downstream. Once the reservoir is in the flood control pool, the discharge will be regulated according to the induced surcharge curve. When the maximum discharge has been attained, the gates will remain open until the pool recedes to elevation 700 feet msl.

Reservoir Regulation Effects

The degree of flood stage reduction afforded to Athens is illustrated by the data in Table 7-3 and on Exhibit 7-13.

Besides the flood modulation attained with the flood control storage, releases to satisfy the demands of downstream water users whose diversions are made directly from the channel will sustain sufficient flow between the dam and diversion points to maintain satisfactory aesthetic conditions during periods of minimal natural flows.

The maximum feasible waste treatment must be maintained at all times, especially for those upper basin water users whose withdrawals are made directly from the reservoir, and whose effluents may be returned to the reservoir.

Pertinent Data

Pertinent data for this project are presented in Table 7-4.

TABLE 7-4
CURRY CREEK DAM AND RESERVOIR
PERTINENT DATA

Item	Elevation (ft.msl)	Pool Area (acres)	Volume (accum) (ac.ft.)	Pool Length along main stems (miles)
Sediment pool	661	1,120	14,000	--
Conservation pool (Recreation and Water Supply)	700	5,720	141,000	22
Flood Control pool	706	6,600	180,000	24
Spillway Design Flood Routing	719	--	--	--
Top of Dam	724	--	--	--

Dam: Concrete dam with impervious earth wings; maximum height 85 feet; crest length (total) including spillway, 1,200 feet.

Dike: Impervious earth fill; total length 180 feet; maximum height, 12 feet.

Spillway: Controlled, concrete weir in valley. Crest elevation 681 feet; crest length, 106 feet including two piers, 8 feet thick. Tainter gates, three, each 30 feet wide, 25 feet high.

Spillway Design Flood: Peak inflow 165,000 cfs, outflow 86,000 cfs, volume 249,000 acre feet (25.82 inches of runoff).

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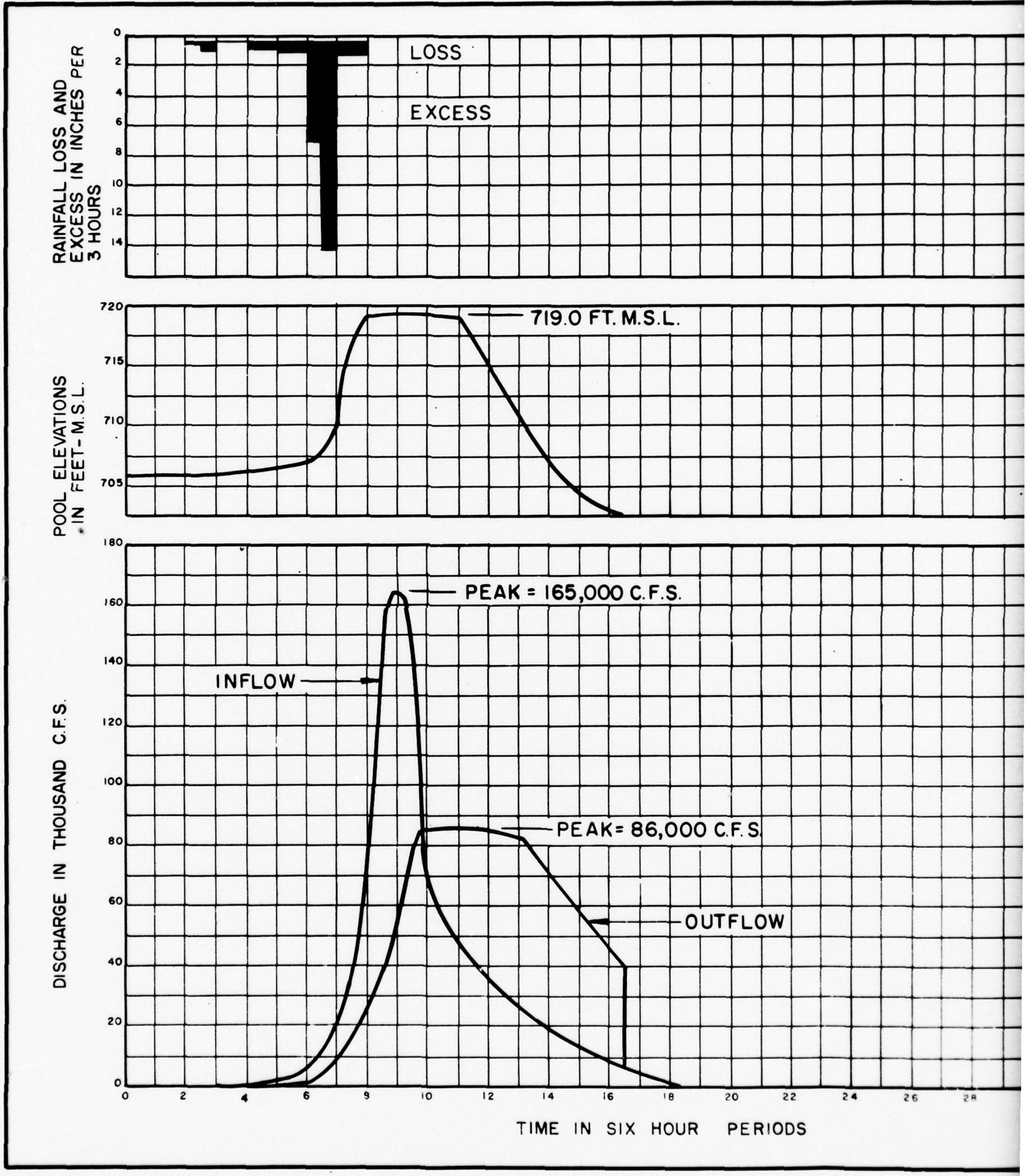

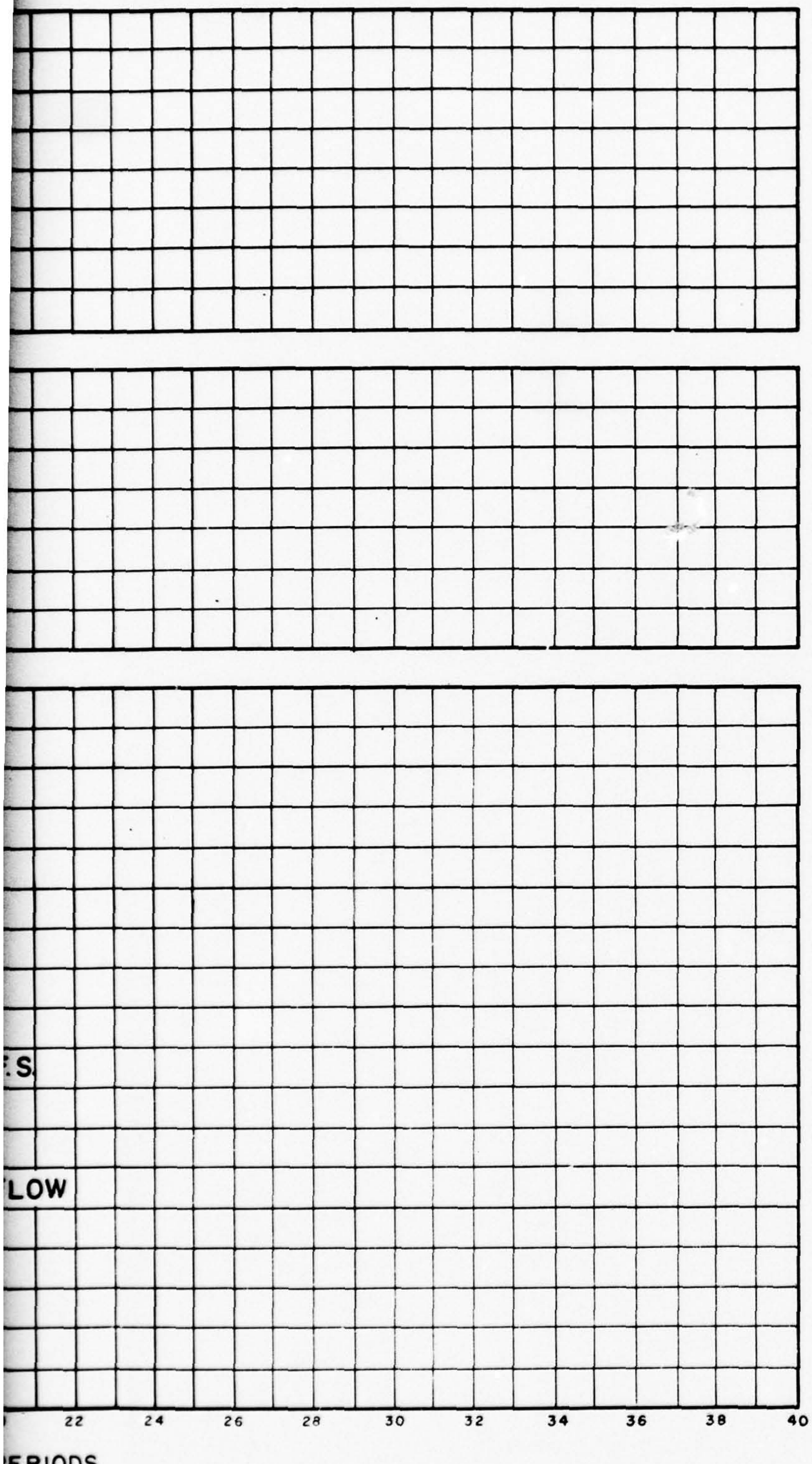

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

INFLOW-OUTFLOW-POOL ELEVATION
RELATIONSHIP FOR
SPILLWAY DESIGN FLOOD

SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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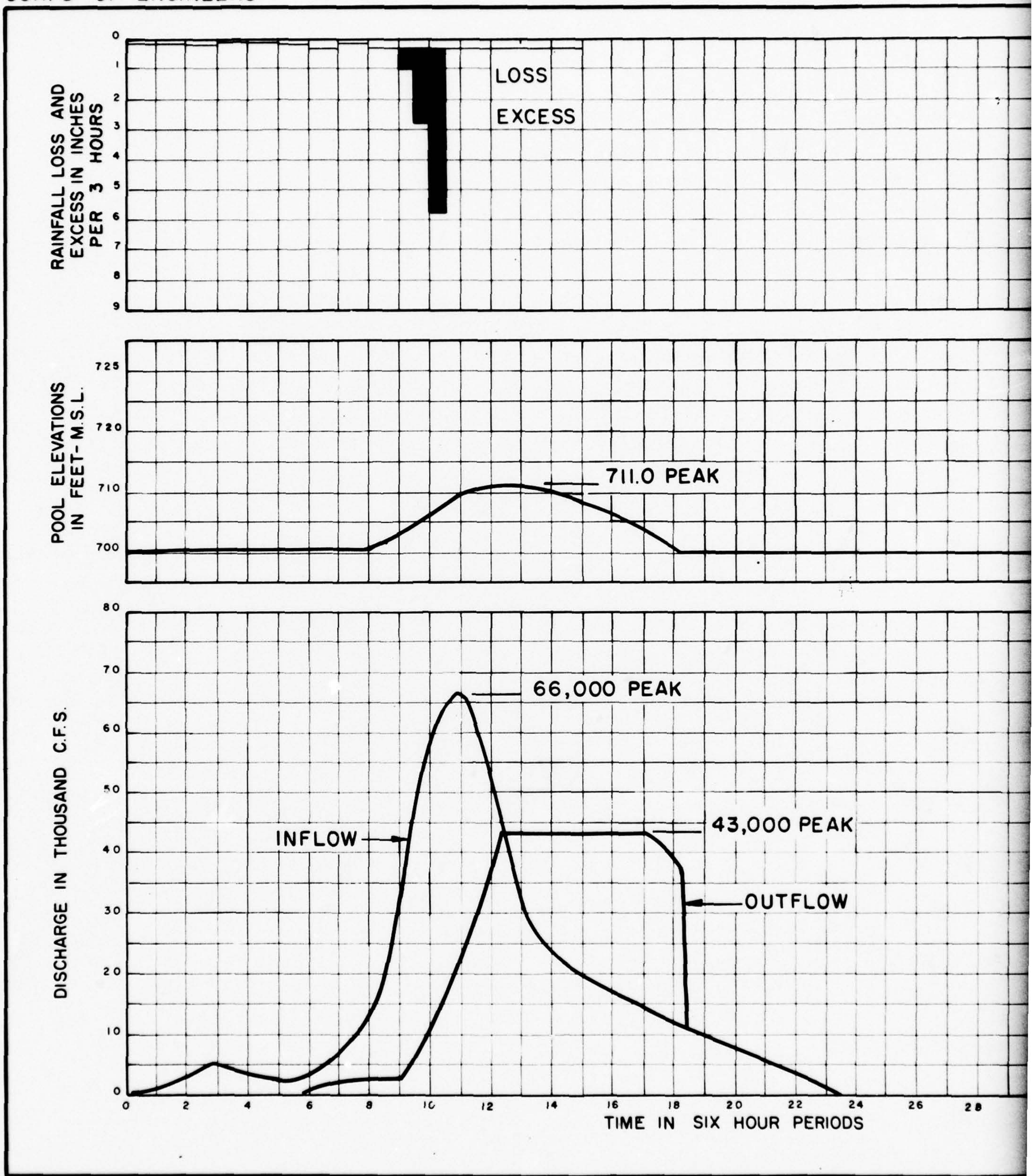

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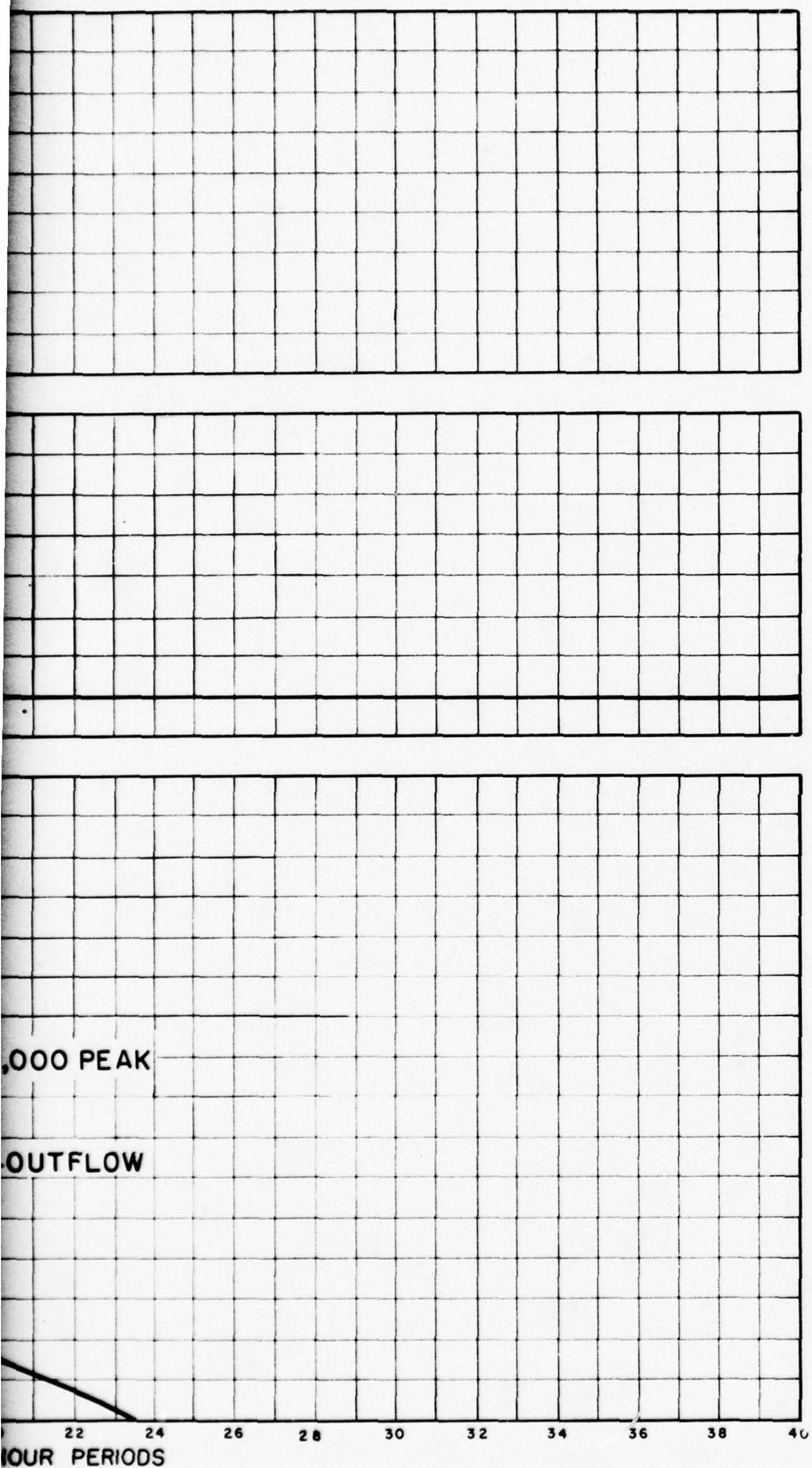

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CURRY CREEK RESERVOIR
NORTH OCONEE RIVER, GA.

INFLOW - OUTFLOW - POOL ELEVATION
RELATIONSHIP FOR
STANDARD PROJECT FLOOD

SCALES AS SHOWN

U.S ARMY ENGINEER DISTRICT, SAVANNAH, GA.

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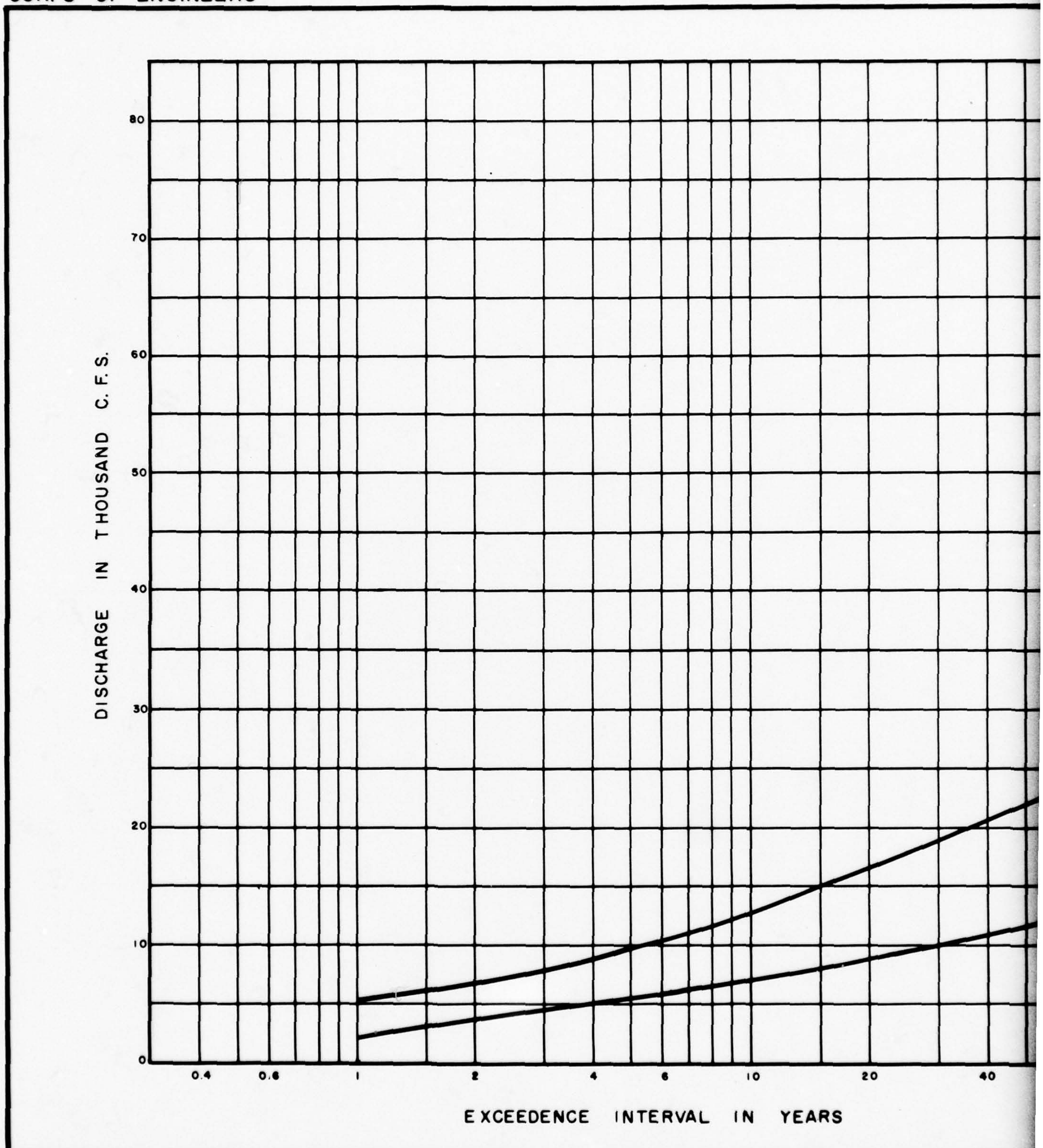

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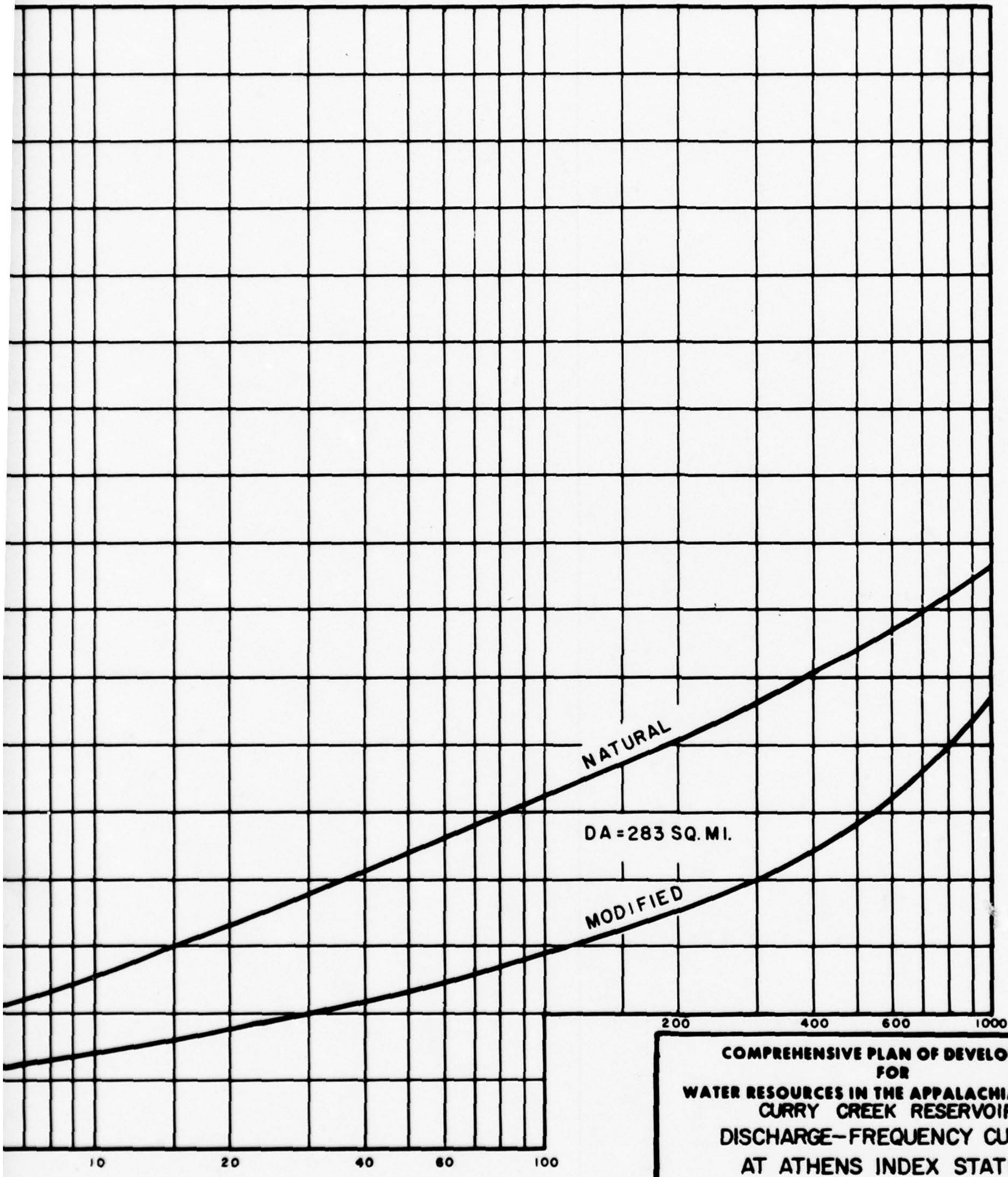

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CURRY CREEK RESERVOIR
DISCHARGE-FREQUENCY CURVES
AT ATHENS INDEX STATION
SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, SAVANNAH, GA.

Exhibit 7-13

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10. GEOLOGIC

The Curry Creek Project and its watershed lie wholly within the Piedmont Physiographic Province. Generally characteristic of this region is deeply weathered igneous and metamorphic bedrock covered by residual soils. The terrain consists largely of deeply eroded valleys and rolling hills with some mountains in the upper portions of the watershed. Elevations range from a maximum of 1,100 feet msl in the upper part of the watershed to about 640 feet msl near the damsite. At the damsite, the maximum relief is approximately 160 feet.

Site Geology

Rock in the project area is composed predominantly of biotite and hornblende gneisses injected with pegmatite and granite. Biotite-hornblende gneiss and saprolite were encountered an average of 26 feet below soil material. The area is typical of the Piedmont Province which has deeply weathered bedrock consisting of ancient metamorphosed igneous rocks intruded by granites and related rock. The rock is intensely weathered for an average depth of 50 feet in the abutments.

Subsurface Investigation

Four core borings were made in the damsite area along a surveyed preliminary centerline. Soil cover encountered in borings ranges in thickness from 10.5 feet to 34.5 feet. Residual soils of the area are composed primarily of silt (ML) with some layers of silty sand (SM). The centerline was later moved 150 feet upstream to take advantage of existing slopes. The location of three of the pertinent core borings are shown on Exhibit 7-2. Drilling logs are shown in Exhibit 7-14. No previous investigations other than surface investigations have been made at this site.

Archaeological

Numerous sites of sufficient scientific and archaeologic interest to warrant further investigation were found by personnel of the Department of Anthropology and Archaeology of the University of Georgia in a survey conducted in late 1967. A summary of the area is presented in Exhibit 7-15. Of 38 sites found, six were considered as having major importance and worthy of intensive investigation. Funds sufficient to cover the estimated survey and salvage expenses were included in the project cost estimates, to be funded by the Dept. of Interior.

Foundation Determinations

The foundation rock is composed predominantly of biotite and hornblende gneisses injected with pegmatite and granite. Residual soils range from 10.5 feet to 34.5 feet and are composed primarily of silt with some silty sand. Weathering extends to considerable depths in the abutments.

The concrete portions of the dam should be founded approximately five feet into firm rock and the earth wings can be placed on the residual soil with no special treatment after clearing, grubbing, and stripping. A single-row grout curtain with holes spaced five-feet-on-center and approximately 30 feet deep would be used throughout the length of the dam.

Reservoir Condition

No leakage problems are expected to exist in the reservoir area.

Construction Materials

The embankment would be a homogenous section of impervious materials. The material available from the excavation for the concrete portions of the dam would be used in the embankment. Borrow areas for additional material required can be located in the immediate area. Soil within the site or near it is adequate in quantity and quality for the approximately 250,000 cubic yards required. Materials for concrete are available from local commercial sources. Aggregate quarries could be established in the vicinity of the project.

Mineral Resources Affected

Investigations made to date have not revealed any valuable minerals in the reservoir area or nearby.

Conclusion

Investigations indicate that a dam can be constructed and a reservoir developed at the Curry Creek site on North Oconee River, without any major geologic problems.

Hole No. 1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 1 OF 2 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT 5" Auger, 2 3/4x3 7/8 D.B.
2. LOCATION (Coordinates or Station) Sta 56 + 80, 10' Right Centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Savannah District, Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) 1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED 5 — UNDISTURBED 0
5. NAME OF DRILLER "Doc" Abbott	14. TOTAL NUMBER CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Not Encountered
	16. DATE HOLE — STARTED 19 Apr 67 — COMPLETED 19 Apr 67
7. THICKNESS OF OVERBURDEN 26.5'	17. ELEVATION TOP OF HOLE 717.5'
8. DEPTH DRILLED INTO ROCK 11.5'	18. TOTAL CORE RECOVERY FOR BORING 60 %
9. TOTAL DEPTH OF HOLE 38.0'	19. SIGNATURE OF INSPECTOR Clyde C. Gambrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0–8		ML - Silty fine sand Tan		1	NOTE: Soils field classified in accordance with the Unified Soil Classification System.
	8–15		Red Slightly plastic w/mica		2 3 4	
	15–20		Red/Tan			
	20		SM- Tan Silty Sand w/gravel		5	
	21–26.5		ML - Tan very fine sand w/mica & gravel			NOTE: Scale change 25.0'
691.0'	26.5		Top of Rock 26.5'			Set Casing to 27.0' Auger refusal 27.0'
	26.5–28		Biotite-Hornblende gneiss, and Saprolite. Intensely weathered. brecciated texture.		1	

CONTINUED ON SHEET # 2

Hole No. 1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 2 OF 2 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Biotite-Hornblende Gneiss and Saprolite. Intensely weathered. Brecciated texture, Low angle foliation.	58		Pull # 1 26.5' to 31.5' Run 5.0' Rec 2.9' Cl. 2.1'
	30				1	
	32					
	34			62		Pull # 2 31.5' to 38.0' Run 6.5' Rec 4.0' Cl. 2.5'
	36					
679.5'	38		Bottom of Hole 38.0'			

Hole No. 2

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Athens, Ga.	SHEET 1 OF 5 SHEETS

1. PROJECT: Curry Creek Dam Site	10. SIZE AND TYPE OF BIT: 1 1/2" SS, 2 3/4x3 7/8 DB
2. LOCATION (Coordinates or Station): Sta 45 + 94 Cl.	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Savannah Dist. - Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): 2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 4; UNDISTURBED 0
5. NAME OF DRILLER: "Doc" Abbott	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ~~ELEVATION~~ GROUND WATER: Depth 44.3'
	16. DATE HOLE: STARTED 20 Apr 67; COMPLETED 21 Apr 67
	17. ELEVATION TOP OF HOLE: 722.3'
7. THICKNESS OF OVERBURDEN: 10.5'	18. TOTAL CORE RECOVERY FOR BORING: 83 %
8. DEPTH DRILLED INTO ROCK: 69.3'	19. SIGNATURE OF INSPECTOR: Clyde C. Gambrell
9. TOTAL DEPTH OF HOLE: 79.8'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g — 0 10 20 40 60 80 100
			ML - Silty fine sand w/ mica and decomposed rock layers.		1	11
						14
						100/0.5
	5		Tan		2	100/0.3
						66
			Tan/gray			100/0.6
711.8'	10		Top of Rock 10.5'		3	85
			Biotite Gneiss Saprolite			100/0.6
						100/0.3
						100/0.8
	15				4	100/0.4
						65
						100/0.1
	20					100/0.6
						100/0.1
						100/0.0
	25					100/0.1
						100/0.4
	30					

Continued on Sheet # 2

NOTE: Soils field Classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT: Number required to drive 1 1/2" ID splitspoon w/140 lb. hammer falling 30".

Hole No. 2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 2 OF 5 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Biotite Gneiss saprolite. foliation about 10°.			
	32			38		Pull # 1 30.0' to 35.3' Run 5.3' Rec 2.0' Cl. 3.3'
	34					
	36				1	
	38			57		Pull # 2 35.3' to 41.3' Run 6.0' Rec 3.4' Cl. 2.6'
			Hornblende gneiss. Intensely to mod. weath., badly broken. foliation aobut 15°, variable.			
	40					
	42		CONTINUED ON SHEET # 3			

Hole No. 2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 3 OF 5 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
WT 44.3' 4/21/67	44		Hornblende-biotite gneiss, gray, contains augen. brecciated texture. Mod. to int. weath. foliation about 15°.	91	1	Pull # 3 41.3' to 45.9' Run 4.6' Rec 4.2' Cl. 0.4'
676.4'	46		Base Intensely Weath. 45.9'			
	48, 50			100		Pull # 4 45.9' to 51.2' Run 5.3' Rec 5.3'
	52		Biotite-augen gneiss. foliation about 15-20°. Contains some hornblende. Mod. to slt. weath. no high angle jnts., many stained foliation breaks.		2	
	54		CONTINUED ON SHEET # 4			

Hole No. 2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 4 OF 5 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	56		Biotite-augen gneiss . Foliation about 15°-20°. Contains some hornblende. Mod. to slt. weath., no high angle jnts., many stained foliation breaks. BREAKS: Foliation, stained at: 51.7';51.8'; 52.1';52.3'; 52.8';53.0';53.5';54.2'; & 60.4'.	97	2	Pull # 5 51.2' to 60.7' Run 9.5' Rec 9.2' Cl. 0.3'
	58					
	60					
			60.7' to 62.9' intensely to moderately weathered, badly broken.			
	62					
659.4'			Top Sound Rock 62.9'		3	Pull # 6 60.7' to 70.7' Run 10.0' Rec 10.0' ble
	64		Biotite gneiss, brecciated containing augen and hornblende. fol. about 25°, slt. to mod. weathered.	100		
	66		CONTINUED ON SHEET # 5			

Hole No. 2

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Athens, Ga.	SHEET 5 OF 5 SHEETS

1. PROJECT: Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			Hornblende-biotite gneiss.			
			Contains muscouite, garnets			
			& angular to augen shaped			
			inclusions of felspar &			
			quartz. brecciated. contorted			
	68		banding. slightly weathered.			
			Breaks.			
			63.5' foliation, stained.		3	
			64.4' foliation, stained			
			64.5' foliation, stained			
			64.6' foliation, stained			
	70		64.7' foliation, stained			
			64.9' foliation, stained			
			65.1' foliation, stained			
			65.7', 15° irr. slt. stn.			
			66.1', 15° irr. fresh			Pull # 7
			66.8' low angle, fresh			70.7' to 79.8'
	72		67.5' 20°, slt. stn. Pyrite	100		Run 9.1'
			on joint.			Rec 9.1'
			67.9' low angle, slt. stn.			
			68.5' 20° stn., pyrite on Jnt			
			69.3' low angle, fresh.			
			69.5', 45°, fresh.		4	
	74		70.4' machine			
			70.6' machine			
			72.1' 15° , irr.., stn.			
			73.6' low angle, fresh			
			74.4' low angle, fresh			
			75.4' 20o foliation, fresh			
	76		75.9', 10° fresh			
			77.0' 35° fresh			
			77.9' 20° foliation, fresh			
			79.0', 20°, irr. slt. stn.			
	78					
642.5'			Bottom of Hole 79.8'			

Hole No. 3

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Athens, Ga.	SHEET 1 OF 7 SHEETS

1. PROJECT: Curry Creek Dam Site	10. SIZE AND TYPE OF BIT: 1 1/2" ID SS. 2 3/4x3 7/8 DB
2. LOCATION (Coordinates or Station): Sta. 33 + 60, Centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Savannah, Dist., Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): 3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 4; UNDISTURBED
5. NAME OF DRILLER: "Doc" Abbott	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Not Encountered
	16. DATE HOLE: STARTED 25 Apr 67; COMPLETED 28 Apr 67
7. THICKNESS OF OVERBURDEN: 34.5'	17. ELEVATION TOP OF HOLE: 720.0' ±
8. DEPTH DRILLED INTO ROCK: 64.3'	18. TOTAL CORE RECOVERY FOR BORING: 67 %
9. TOTAL DEPTH OF HOLE: 98.8'	19. SIGNATURE OF INSPECTOR: Clyde C. Gambrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		SM - Fine to Med sand w/roots Red		1	
			ML - Silty fine sand slightly plastic w/mica Red		2	
	5		SM - Silty fine to med sand w/mica White		3	
			ML Red silty fine sand w/ decomposed rock & mica		4	
			SM Brown/white silty fine to med. sand w/mica			
	15		ML - Brown silty fine sand w/mica & decomposed rock layers.			
	30		CONTINUED ON SHEET # 2			

Blows per foot (scale 0 10 20 40 60 80 100), in order of depth: 9, 14, 24, 46, 43, 24, 39, 45, 75, 57, 45, 52, 51, 53, 42, 43, 58, 64, 68, 62

NOTE: Soils Field classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT: Number required to drive 1 1/2" ID splitspoon w/140 Lb. hammer falling 30".

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 2 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) 0 10 20 40 60 80 100
			ML - Tan Silty fine sand w/mica & decomposed rock layers.			88 100/0.4 100/0.3
685.5'			Top of Rock 34.5'			
	35		Saprolite, banded, brown & gray, intensely weathered. Contains a few small garnets.			Augured to 35.5'
	36			16		35.5' to 41.8' Run 6.3' Rec 1.0' Cl. 5.3'
	38				1	
	40					
	40					
	42			39		Pull # 2 41.8' to 51.6' Run 9.8' Rec 3.8' Cl. 6.0
	44		CONTINUED ON SHEET # 3			

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 3 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Saprolite, banded, brown & gray, intensely weathered. Contains a few small garnets			
	46					
672.2'	48		Base Int. Weathering 47.8'			
			Biotite Gneiss, gray, augen gneiss with a few small garnets. foliation dips about 30°. mod. weathered, badly broken.			
	50				1	
	52					
	54			67		Pull # 3 51.6' to 57.4' Run 5.8' Rec 3.9' Cl. 1.9'
	56		CONTINUED ON SHEET # 4			

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 4 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Biotite gneiss, gray, augen gneiss with a few small garnets. foliation dips about 30°. Mod. weathered, badly broken.			
	58		59.6' to 61.4' slightly weathered to fresh. Breaks: 59.7' 45° jnt. 60.0' 30° fol. calcity healed jnt. 60.4', 61.0', 61.1' - 25° foliation breaks, stained.	65	1	Pull # 4 57.4' to 61.4' Run 4.0' Rec 2.6' Cl. 1.4'
	60					
	62		Biotite gneiss, dark gray, Intensely weathered. fol. is near horizontal. numerous breaks. rock is very micaceous with no garnets or augen noted			4.0' Core loss probably in this material
	64				2	
	66			62		Pull # 5 61.4' to 71.9' Run 10.5' Rec 6.5' Cl. 4.0'
			Pegmatite, light gray to white. coarsely crystaline			
	68		CONTINUED ON SHEET # 5			

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 5 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	70		Pegmatite, light gray to white. Coarsely crystaline quartz & felspar with small amounts of mica (Mostly muscouite). Badly broken. Slightly to mod. weathered. Breaks: 67.4' 45° irr., stn. low angle joints, Irr., stn 68.0', 68.7', 69.2', 69.3' 69.5', 69.7', 70.1' 70.1' 45°, irr., stn. Low angles, Irr., Stn.. 70.2', 70.5', 70.7', 71.3', 71.6', 71.9', 72.1', 72.4', 72.5', 72.7', 72.8'.			
	72			•	2	
	74		Granite, light gray, med. grained with no distinguishable foliation. Intensely to Mod. weathered, badly broken.	91		Pull # 6 71.9' to 81.4' Run 9.5' Rec 8.6' Cl. 0.9'
	76		76.1' to 78.4' - slightly to moderately weathered. High angle joints at 78.4', 79.2', 79.3' & 79.4' 77.9' to 78.4' badly bkn zone		3	
	78		Biotite-garnet-augen-gneiss, mod. to int. wea. Fol. about 15° near vert. & fol jnts. Badly broken			
	80					

CONTINUED ON SHEET # 6

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 6 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			79.2'-79.4' Granite, lt. gray, slt. wea., med. grained			
			79.4'-79.6' Pegmatite, lt.gray, corsely crystalline, slt. wea.			
	82		79.6'-81.2' Biotite-garnet-augen gneiss. Int. to mod. weathered. Fol. 25°-30°. Badly broken.			
	84		Hornblende-biotite-garnet gneiss. slt. to mod. weath. 81.2' to 81.4' badly broken. Breaks: 81.9' 45°, stn. 82.0', 82.7', 83.1' 25°, foliation, stained.			
			83.4'-84.0' - Pegmatite.			
	86		Biotite-augen-gneiss, gray, mod. weathered, badly broken, very few garnets.	94	3	Pull # 7 81.4' to 89.7' Run 8.3' Rec 7.8' Cl. 0.5'
632.0'	88		TOP SOUND ROCK 88.0'			
	90		Few garnets. slightly wea. Foliation 25°-30°. Breaks: 88.0' fol., sltly. stn. 88.7' fol., sltly. stn. 89.1' foliation, slt. stn. 89.5' foliation. slt. stn. 89.7' foliation. slt. stn. 90.9' foliation. fresh.		4	
	92		CONTINUED ON SHEET #7			

Hole No. 3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 7 OF 7 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Biotite-augen-gneiss, gray, few garnets. slightly wea. foliation 25°-30°.			
			Breaks:			
	94		91.9'-92.1' bkn. zone, slt. stn.		4	Pull # 8
			92.4' low angle, slt. stn.			89.7' to 98.8'
			92.6' low angle, slt. stn.	103		Run 9.1'
			92.9' fol., slt. stn.			Rec 9.4'
			93.4' machine break			Cg. 0.3'
	96		83.8', 94.1', 84.8' - fol., slightly stained.			
			95.1' - 95.8' (2) high angle jn jnts., stained.			
			95.8',96.0',96.4',96.6',96.9', 97.1' - foliation, stained.			
			97.8' machine break.			
	98		98.3' low angle, slt. stn.			
621.2'			98.4' low angle, slt. stn.	BOTTOM OF HOLE 98.8'		

Hole No. 4

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 1 OF 3 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT 1-1/2" ID Splitspoon
2. LOCATION (Coordinates or Station) Station 7+65, 15' Right	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Savannah District - Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) 4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Doc Abbott	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Not encountered
	16. DATE HOLE: STARTED 24 Apr 67; COMPLETED 25 Apr 67
7. THICKNESS OF OVERBURDEN 25.5'	17. ELEVATION TOP OF HOLE 770.3'±
8. DEPTH DRILLED INTO ROCK 32.6'	18. TOTAL CORE RECOVERY FOR BORING 73 %
9. TOTAL DEPTH OF HOLE 58.1'	19. SIGNATURE OF INSPECTOR Clyde C. Gambrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			ML - Reddish silty fine sand w/mica			
	10					Auger to refusal
	20		Tan & Gray w/decomposed rock			NOTE SCALE CHANGE AT 30.0'
	30		Gneiss Saprolite. Intensely weathered and decomposed. Foliation $30^{\circ} - 40^{\circ}$	40		Pull #1, 25.5' to 31.0', Run 5.5', Rec 2.2', CL 3.3'
	32					
	34					
	36					
	38			37		Pull #2, 31.0' to 40.2', Run 9.2', Rec 3.4', CL 5.8'
	40		CONTINUED ON SHEET 2			NOTE: Soils field classified in accordance with

Hole No. 4

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 2 OF 3 SHEETS
1. PROJECT Curry Creek Dam Site		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			BASE OF INTENSE WEATHERING			
			Biotite-hornblende gneiss, moderately weathered, badly broken TOP OF SOUND ROCK 41.6'			
	42		Biotite-hornblende gneiss, contorted banding, contains garnets, augen, pyrite and muscovite. Slightly weatherdd.			
	44		BREAKS: 41.6', 20° irregular, fresh 43.3', 20° irregular, fresh 43.9', 40° irregular, fresh 44.8', low angle, sl. stn.	71		Pull #3, 40.2' to 44.6', Run 4.4', Rec 3.1', CL 1.3'
	46		Break, 46.4', low angle, fresh		1	
	48		Break, 48.4'(2) low angle, stained, pyrite on jnt face Break, 48.7' low angle, stn, pyrite on jnt face Break, 49.1' 15°, stn, pyrite on joint face			
	50		Break, 49.5', 20°, stn, pyrite on joint face Break, 50.0', 25°, stn, pyrite on joint face Break, 50.2' 20°, stn, pyrite on joint face	116		Pull #4, 44.6' to 51.3', Run 6.7', Rec 7.8', CG 1.1'
	52		CONTINUED ON SHEET 3			

Hole No. 4

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Athens, Ga.	SHEET 3 OF 3 SHEETS

1. PROJECT Curry Creek Dam Site	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Biotite-hornblende gneiss, contorted banding, contains garnets, augen, pyrite and muscovite, sl. weathered.			
			Breaks:			
	54		51.3' 30° stn, pyrite on jnt face.			
			52.7' 25° stn, pyrite on jnt face.			
			53.2' 30° stn, pyrite on jnt face.			
			53.8' 25° stn, pyrite on jnt face.			
			54.1' 25° stn, pyrite on jnt face.			
	56		54.8' 20° stn.			
			55.3', 15° stn.			
			55.4' 15° stn.			Pull #5, 51.3' to 58.1',
			56.1' low angle, stn.		2	Run 6.8', Rec 6.6',
			56.2', 30°, stn, slickensides	99		CL 0.2'
			56.3', 30°, stn.			
			56.8' 25°, stn, pyrite on jnt face.			
	58		57.2' 25°, stn, pyrite on jnt face.			
			57.4' 25°, stn, pyrite on jnt face.			
712.2'			BOTTOM OF HOLE 58.1'			

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
SOUTHEAST REGION, P. O. BOX 10008
FEDERAL BUILDING, RICHMOND, VA. 23240

IN REPLY REFER TO:
L7423 SER(CA)

DEC 28 1967

District Engineer
U. S. Army Engineer District, Savannah
P. O. Box 889
Savannah, Georgia 31402

Dear Sir:

Enclosed for your review and comment is a copy of a "A Preliminary Appraisal of Archaeological, Historical and Related Natural Science Resources in the Curry Creek Dam Reservoir" by Gordon M. Midgett. This report was produced for the subject program by the University of Georgia under Purchase Order 910-033.

While no outstanding natural science values were located in the area, extensive swamps and beaver ponds were noted. Such resources would be vital to any ecological studies of the flora and fauna of the basin and would also have important implications for the study of early subsistence patterns.

The area of the proposed project was settled in the late 18th century and a variety of sites survive from the early periods of settlement. The majority of these are mill sites, pioneer habitation sites, and the surviving remnant of a pegged log house. It is doubtful that any of these sites would receive recognition under a state assessment resulting from the Historic Preservation Act (PL 89-665).

The proposed project area has a good potential for archeological research in both aboriginal and early historic sites. One concentration of stone mounds and linear walls, if of aboriginal construction, could yield important archeological data.

The cost of archeological and historical survey and salvage should be recognized as part of the total project development cost to the government. We recommend that the Corps of Engineers consider the inclusion of an estimate of $20,000 for salvage in its cost projections. Should

the proposed reservoir be authorized, we further recommend that the above amount be included by the Corps of Engineers in its request for construction funds.

Sincerely yours,

Charles S. Marshall

Charles S. Marshall
Acting Regional Director

Enclosure

A

PRELIMINARY APPRAISAL
OF

ARCHAEOLOGICAL, HISTORICAL,

AND

RELATED NATURAL SCIENCE RESOURCES

in the proposed

CURRY CREEK DAM RESERVOIR

BASIN

Gordon M. Midgett

Sheet 2 of 6

I. DESCRIPTION AND NATURAL VALUES

Survey of the North Oconee River area behind the proposed dam at the confluence of the North Oconee and Curry Creek and extending to the upper limits of the reservoir approximately one half mile below Hurricane Shoals and Interstate 85 was begun on October 12, 1967 and continued through November 26, 1967 by the Department of Anthropology and Archaeology of the University of Georgia.

The topography of the lake basin stretches Northward for nine miles with little change in the pattern of ridges and swamps bordering the rivers. The ridges afford in many places precipitous slopes to the rivers and low areas are invariably very swampy. Fall rains have aggravated the condition by saturating the margins of all stream confluences. Hardwood trees form a dense barrier from the river up the slopes, and in all low areas. Higher ground alternates in extensive pine forests with occasional old fields, well grown up in sage and briar patches. All culturally diagnostic material could be seen only on firelanes, gulleys, eroded slopes, unused roads, banks, and to some degree in sage fields.

One of the outstanding resources in the Basin are the Hardwood stands. On Border Creek about 1/4 mile from the Jackson mill the author found the decayed white stump of a chestnut. From around the base of this stump several small trees were trying to grow. Since the leaves had

fallen and the tree didn't look diseased, it was not determined that the tree had the blight.

Extensive swamps are also extant. These are very important areas for ecological studies of the flora and fauna of the basin. Early sources mention specifically that the swamps were for the most part canebrakes. Currently there is a large beaver population in the basin and large numbers of deadened trees which have been destroyed by sheets of backed up waters. That extensive areas were covered by water backed up from beaver dams in Georgia is substantiated by Col. Hawkins, in 1797 who noted that on the lower edge of today's Columbus, a 40-acre beaver pond was capable of being drained "at small expense of labor." Most of the ponds in the basin backed up by beaver activity are shallow affairs but they created an unusual biotic adjustment for the surrounding ecosystem. Such systems would have had important implications for early subsistence patterns. Dr. Edmunstin of the University of Georgia is currently studying Beaver Pond Distribution in Georgia.

II. SHORT SUMMARY OF PIONEER CULTURE AND EARLY SETTLEMENT IN THE CURRY CREEK BASIN AND NORTHEAST GEORGIA

Numerous mill sites, remnants of loghouse culture, old bridges, roads and trails as well as a responsive community of lineal descendents constitute the major resources for reconstructing pioneer culture in this basin. The author's daily round of activities encountered geneologists

clamoring around in the Old Pioneer graveyards, and bottle hunters scouring abandoned farm houses for old mason jars, etc. The general stores were museums of Pioneer Culture and their owners the depositories of local folklore.

Although this topic could be greatly expanded, the author feels constrained by the magnitude of the data to select these few facts:

1. The area was settled predominantly from the Eastern part of the state in the 1780's and 90's.
2. The land on which the University of Georgia is now located was in the possession of Daniel Easley who had as early as 1800 an active mill on the Oconee at Athens, and in 1803 a small dam on the river itself. Easley was originally from the Jackson County north Oconee area.
3. Improvement of the river was early a subject of popular interest. One bill before the legislature wanted to redirect the Chattahoochee river in Northern Jackson County, now Hall, into the Oconee. The proposed canal was a practical possibility but the bill failed.
4. Most of the early settlements in Jackson County were on either the north Oconee or the Mulberry fork, (Middle Oconee).
5. Jackson County was created in 1796 out of an area that may have been part of the illegal state of Franklin set up by Elija Clarke and others. Clarke's settlements were known as the Wofford

Settlements and were both north and south of the basin on the west side of the river. His state was a violation of the treaty of 1783 which gave all those lands east of the Oconee to the Indians. There is a possibility that the early iron works at Hurricane Shoals was part of this chain of illegal settlements.

6. Jackson County was the mother Co. of the following counties: Madison; Clarke; Hart; Oconee; Walton; Gwinnett; and Banks

7. Jackson County produced most of the men from the Northeastern part of the state who became prominent in various fields from 1790 to the Civil War.

8. No major trails are within the Basin although the Echota trading path parallels the basin on the east bank. Its route lies approximately on 441 from Commerce to Athens.

9. No major conflicts were fought in the North Oconee River area during the Civil War. Action was limited to picket's engaging one another at the river crossings.

III. ARCHEOLOGY

Previous Work in the Basin

With the exception of one survey entry there has been no qualified scientific archaeology done within the proposed basin. Laboratory of Archaeology files carried five sites for Jackson County with one site in the basin added by Robert Wauchope in WPA surveys. This was a "Village site on the right bank of the Oconee River to the left of the

highway going from Commerce to Jefferson. Exact spot not recorded." This site was not relocated.

Swanton's ethnographic materials listed no sites for this section of the Oconee.

Conduct of the Survey

Sites were evaluated primarily on the basis of surface materials. The more preliminary nature of the survey suggested that location and some relative weighing of site importance were the primary objectives. However, the extent of concentrations, and the amount of stratigraphy could only be roughly determined, if at all, by purely surface speculation.

Most of the area was covered by foot from secondary roads leading into the basin. For about a week a scout truck was used in covering difficult terrain at greater distances from secondary roads than would have been economical to cover by foot.

38 sites were found in the basin. When the basin is cleared this concentration of sites indicates that perhaps four to five times the actual number now on record would be in the reservoir. Of the thirty-eight sites, six can be considered as having major importance and should receive extensive investigation. Twelve additional sites can be regarded as important, although their exact potential cannot be ascertained by surface survey. Five of the thirty-eight sites are of restricted importance but should be tested.

Selected Site Descriptions

9Jk6

This site is located about 1/4 mile north of Pott's Little Red Store on the east bank of the Oconee River. The principle feature of the site is what appears to be an effigy in the shape of a turtle and composed of quartzite rocks averaging 10" to 26" in diameter. The maximum height of this stone arrangement is about two feet with a diameter of twelve feet. Much of the structure is buried due to the slow erosion of the slope above. The forward half of the structure has tumbled into the river. Similar effigies have been found in Putnam county in association with stone mounds and linear formations of rock composed primarily of quartzite. A site of this type can be considered a site of considerable archaelogical potential in terms of its regional associations and the probability that it is closely related in time to other sites on the ridge.

9Jk8

About 500 yards upstream from the confluence of Finadee's Ditch and the Oconee on the northeast side of the ridge near 9Jk6 on the 680' contour is a spring, locally known as Gum Springs. Immediately to the southwest of the spring is the first of about sixty stone mounds located within an area of one acre. The mounds are tightly clustered together about 80 yards west of the spring, with an average distance of 20' between the mounds. On the northern extremity of the cluster is a

well-defined wall about 3' high and 70' long composed of quartzite rock. This wall rests on about the 680' contour. About 60 yards south proceeding upslope is another wall equally well preserved, but almost completely buried on the south side. Its northern face measures 2 1/2 to 3' high. This wall is approximately 60' long. In the area between these two walls and the spring to the northeast are approximately forty of the sixty stone mounds. These vary in size from small clusters not more than two feet high and four feet in diameter to large oval structures 3 1/2' high and 4' x 7'. More of the mounds are located sporadically above the higher wall until the narrow table on top is reached. No mounds were encountered here, though several were found on the opposite slope. About 100 yards north of the last linear structure is another similar wall. This wall is on the southwest slope of the ridge and approximately 350 yards from Jk6. Several stone mounds are in association with this structure.

9Jk20-A

Davis Farm Site. About 800' north of dam axis on east bank of Oconee. Several rock mounds, a linear rock arrangement and a large boulder with numerous well-shaped nutting holes from 4" in diameter and 4" deep to 1" in diameter and 3/4" deep. Very important site.

9Jk21

On hill just east of Jk20 are the remains of a pegged log house, chimney tumbled, pieces of blue feather edge ware. Important as possible example of early log house culture in the area. Possibly the structure itself is late 18th century.

The following sites can be lumped into general categories and discussed as a unit:

Mill sites

9Jk23 Randolphs--Little Curry Creek

9Jk24 Williamson's--Little Curry Creek

9Jk25 Jacksons #2, between Potts and Burns

9Jk26 Wool mill--Davis Property, Border Creek, confluence Oconee

9Jk27 Jackson Mill #1 head of Border Creek reservoir area--Clink Scales property.

Early Settlements

9Jk32 Tumbling Shoals--Yamacutah--Pioneer settlement

9Jk33 Hurricane Shoals--Iron works

9Jk34 Groaning Rock--Pioneer settlement

9Jk35 Extant covered Bridge--Hurricane Shoals

Two features just outside the reservoir offer a number of possibilities that would have residual value:

1. Crawford Long Museum in Jefferson near Curry Creek bridge.
2. Hurricane Shoals, 1/2 mile above the reservoir is one of the most picturesque sites in Ga. Water rushes down a steep Granite outcrop for almost four hundred yards. It is just off the Maysville-Jefferson road and 185. A covered bridge leads to the premises. Local people use it as a holiday area for swimming, picnics, etc. Reference has been made to an early iron works located at the shoals. Exact date unknown but associated with early pioneer development.

11. STRUCTURAL

Principal structural features are shown on Exhibit 7-2. The 700-foot concrete section consists of two non-overflow sections, each 297 feet long, and a 106-foot spillway section. The maximum height of the dam is about 85 feet to top of dam at elevation 724. Abutting the concrete section, the right-bank embankment would be 290 feet long and the left-bank embankment, 210 feet. The embankment, of selected impervious material with a chimney drain and sand drainage blanket to intercept any potential seepage, would have a downstream slope of 1 on 2-1/2 and an upstream slope of one on three with riprap protection extending from a berm at elevation 690 to the top of the dam.

The spillway would have a crest elevation of 681 and flow would be controlled by three 30' x 25' tainter gates. Two eight-foot piers would be provided for gate mountings. The ogee weir would terminate in a stilling basin where energy dissipation would be accomplished by impact on two rows of baffles and the end sill. Several different types and sizes of spillways were investigated. A free-overflow type of spillway in a saddle proved to be nonfeasible because of the elevation of bedrock and extreme quantities of excavation.

A service road would traverse the embankments, non-overflow sections, and a bridge across the spillway.

A low-lying saddle located about 1,000 feet northeast of the left abutment would require a small dike to prevent spills in the event of floods of standard project magnitude. The crest length of this dike would be 180 feet and the maximum height, 12 feet. The side slopes would be one on 2.5 and the upstream slope would be protected by riprap.

Low-flow releases to meet downstream water supply needs would be made through two 4 x 4-foot sluices located in the spillway structure. The intake inverts would be at elevation 640. The results of current studies of the effects of thermal stratification on water quality and the optimum blending of epilimnial and hypolimnial releases, and experiments to break up thermal stratification will be considered in determining whether one or more additional sluices, at higher elevations, would be required. If these are found to be needed, they could be placed in the gate piers or at other locations in the spillway structure.

Unskilled and semi-skilled construction workers would be recruited from the reservoir of unemployed or underemployed of the project area. Qualified construction workers would be available at Athens or could be recruited from the Atlanta area, about 60 miles southwest of the project location.

Construction is expected to be completed in about three years from its initiation. All initial recreation facilities will be completed prior to impoundment to permit orderly use of the resource and to assure the total project benefits claimed may be realized, including recreation benefits.

12. RELOCATIONS

There are no railroads which would be affected by the Curry Creek Reservoir project.

About three-tenths of a mile of State Route 15 and about 2.2 miles of State Route 335 would be inundated by the reservoir. Also, several county roads would be affected by the project. Relocation and modification of the State Routes would be required. However, the affected segments of the county roads mainly furnish access to tracts which would be acquired for project purposes so replacement would not be required. The stubs of these roads would be retained for access to the reservoir and its adjacent recreation areas. Other affected county roads would be relocated or modified.

Minor modification of a power line which crosses the North Oconee River about three miles southwest of Commerce would be required. A telephone line which crosses Curry Creek near Jefferson, and the North Oconee River and its tributaries about five miles northeast of Jefferson would also require modification. There are no known pipelines crossing the reservoir area.

There is one cemetery, adjacent to Bethany Church, which would have to be relocated. All highway, utility and cemetery relocations will be coordinated with the non-Federal agency responsible for the operation and maintenance of the recreation resources of this project, in order to assure that these relocations will be accomplished in a manner to prevent environmental intrusions.

13. REAL ESTATE

The proposed guide taking line is the 711 contour, five feet above the flood control pool. Wherever this contour is less than 300 feet horizontally from the 706 contour, the taking should be increased to that extent. Total joint use land area proposed for acquisition is 8,050 acres. An additional 2,000 acres above the guide taking line is to be acquired for recreation area development. Under project conditions, the downstream fishery is expected to be greatly improved and fifteen acres are to be acquired for fisherman access and boat launching purposes. The eleven fishing sites located downstream will be acquired in fee.

To offset the loss of hunting opportunities provided by the lands which will be inundated by the reservoir, it is proposed that 700 acres suitable for this purpose be acquired. All land is to be purchased in fee for purpose of mitigating wildlife losses.

Thirty-five buildings are located on tracts in the reservoir area which would have to be cleared. These and other improvements on the lands which would be acquired for project purposes consist mostly of rather modest rural sets. There are no urban areas or thickly populated rural areas in the project area.

Appraisal of the property involved was based on a preliminary field inspection of the area, examination of recent aerial photographs, analyses of recent sales of comparable tracts, and value data from active dealers in farm property in this area.

Severance payments are expected to be relatively small, as anticipated acquisition would result in very little damage of this nature.

There are no known mineral resources in this area which would have to be acquired.

14. RECREATION

An inventory of the water and land areas available for outdoor recreation by the Bureau of Outdoor Recreation (BOR) indicated a present and future demand for water-associated recreation opportunities in the project area. BOR concluded that present water areas and those to become available in the near future would be adequate for boating until year 2000. However, other recreation activities are expected to result in initial use of 300,000 days and by year 2020, 1,500,000 days. Therefore, there is an immediate need for the recreation facilities to be provided by the proposed Curry Creek Reservoir and its recreation development. Besides the general recreation attendance, the reservoir would support 101,120 fisherman days, an increase of 98,200 over the present stream fishery. Included in the figures is the 12 miles below the dam which will support, 1,920 fisherman days after the project; whereas, it now supports 960 fisherman days.

The initial recreation development of lands adjacent to Curry Creek Reservoir would consist of four areas intensively developed for general recreation, and eight additional locations primarily intended for access to the reservoir and tailwater area. At these strategically located access points, the facilities would be limited and would consist of mainly boat launching ramps and parking areas, with some picnic units. At the four primary locations, on ridges which would become peninsulas jutting into the reservoir, facilities for swimming, picnicking, camping, hiking, boating, and sightseeing such as swimming beaches and bathhouses, picnicking and camping units, walkways, hiking trails, boat launching ramps, parking areas, utilities, and appropriate administration buildings and sanitary facilities would be provided. Existing State and county roads which would be severed by the reservoir would provide ready access to all twelve areas, and a network of circulation roads to adequately distribute recreationists and other visitors should suffice.

In their analysis of the recreation facilities needed for the project, the U.S. Fish and Wildlife Service concluded that accesss should be furnished for fishermen and general recreationists along the North Oconee River from the dam to Athens. They recommended that parking facilities be provided for 20 fishermen cars and those of general recreationists at the

tailwater site just below the dam. This is one of the access sites discussed in the preceding paragraph. Also, the Fish and Wildlife Service recommended an average of one one-acre fisherman-access site per mile to Athens. This would provide eleven additional access sites to utilize the downstream fishery.

During the advance engineering and design stage, consideration will be given to the outlet works capable of providing the most desirable water quality for downstream fisheries consistent with water supply needs.

The proposed acquisition of 2,000 acres, in addition to the land required for project purposes, would provide adequate areas for the initial development, and future installations, to serve the public at sites compatible with the recreation usage pattern.

An additional area adjacent to the reservoir would be acquired to mitigate loss of wildlife habitat and hunting opportunities due to project construction. The acreage is estimated not to exceed 700 acres with the exact amount being contingent upon a more detailed study in the advance engineering and design stage of project development. This land would be located near the head of the reservoir and State Route 15.

The proposed recreation development of the Curry Creek Reservoir project is in consonance with the Georgia State-wide Outdoor Recreation Plan. Non-Federal administration of the outdoor recreation development of the Curry Creek project is considered appropriate and is recommended.

SECTION IV - COST ESTIMATES

15. PROJECT COSTS

The total estimated construction cost of the proposed multiple purpose project is $17,757,000. Construction costs for the dam and appurtenances were based on detailed layouts shown on Exhibit 7-2. Estimates for real estate acquisition, roads and utilities relocations, and reservoir clearing are according to current policies and procedures. Cost for the recreation facilities were determined by using unit costs of comparable facilities on existing reservoirs. Unit prices for the cost estimates are based on November 1967 price levels and are comparable to similar work of this nature performed in nearby areas. The estimates of first costs include contingencies, engineering and design, and supervision and administration. Table 7-5 is a summary of first costs. A detailed estimate of first costs is given in Table 7-6. The estimated cost of the downstream fishery is $32,700, or an annual financial charge of $3,500 (see Table 7-8). Detailed estimates of the first costs for the downstream fishery is given in Table 7-8. Beautification will be accomplished in accordance with existing requirements with cost included as contingencies.

Project Investment Costs

The total investment costs for the project includes the construction cost plus interest on the initial increment. The current Federal interest rate of 3.25 percent and a three-year construction period were used to determine the interest during construction.

Estimates of Annual Charges

Annual charges were computed on the gross investment using the current Federal interest rate of 3.25 percent and an amortization period of 100 years. Operation and maintenance charges for the reservoir were based on current cost of similar projects and include costs for major replacement items. Detailed estimates of annual charges are given in Table 7-7.

16. DEVELOPMENT COSTS

The estimated costs of employment and income-generating firms which are expected to locate or expand within the project impact area subsequent to commitment of the water project are estimated to be on the order of $8.75 million. This amount represents the costs of a textile finishing plant and a poultry processing plant, and induced investment in service and trade sections along with investment in recreational services associated with expenditures of recreational users. The finishing and processing plants are dependent upon additional water supplies to locate economically in the project impact area. Augmented streamflow from water supply storage would allow necessary withdrawals to accommodate processing

requirements without inducing serious quality and quantity problems downstream. Location of these firms in this area appears highly probable because of the agglomerative effects of industry development in the area. The presence of these forces will likely stimulate construction of the plants in advance of actual completion of the water project, with the firms accepting the risk of temporary low flow occurrences, provided the project is programmed for construction in the near future.

The omission of the costs and benefits, represented in the expansion of Athens, associated with the provision of adequate water supply and reduced flood flow is deliberate, because Athens is outside of Appalachia and because of the difficulty in adequately defining the diverse linkages between Appalachia and Athens. In all probability, the effects at Athens and subsequently to the Appalachian Region and to the nation will greatly exceed the calculated costs and benefits. However, the Athens area is experiencing relatively full employment, and the employment gains outlined above would appear to shrink unemployment to acceptable levels within the three-county impact area. Therefore, remaining gains would have to accrue from increasing the income levels of otherwise employed persons. The clear delineation of these gains has proved to be unattainable in the instant investigation, thus the apparent conservatism in estimating developmental costs and benefits.

TABLE 7-5

SUMMARY OF FIRST COSTS FOR CURRY CREEK PROJECT

Item	Cost ($1,000)	Cost with indirect costs distributed ($1,000)
Lands and damages	$ 1,986	$ 1,986
Relocations	4,400	5,060
Reservoir clearing	716	823
Dam and appurtenances	4,300	4,945
Recreation:		
Initial	1,055	1,213
Future increment	3,013	3,465
Total recreation	4,068	4,678
Buildings, grounds and utilities	125	144
Permanent operating equipment	100	115
Mitigation lands development	5	6
Engineering and design	823	-
Supervision and administration	1,234	-
Total estimated cost	$17,757	$17,757
Less future recreation increment		-3,465
Total estimated initial cost (November 1967)		$14,292

TABLE 7-6

DETAILED ESTIMATE OF FIRST COST
FOR CURRY CREEK PROJECT

Item	Unit	Quantity	Unit Price	Amount
		Lands and Damages, Joint-Use Lands		
		Dam and Reservoir Area		
Fee acquisition				
Cropland and pasture	Acre	1,850	$ 80	$ 148,000
Cropland and pasture	Acre	630	160	100,800
Woodland and pasture	Acre	5,570	40	222,800
Timber	Job	1	-	143,000
Improvements	Job	1	-	300,000
Acquisition costs	Job	1	-	186,000
Resettlement costs	Job	1	-	12,000
Contingencies				370,400
Total				$1,483,000
		Mitigation Land Area		
Fee acquisition	Acre	700	140	98,000
Improvements	Job	1	-	4,000
Acquisition costs	Job	1	-	4,000
Resettlement costs	Job	1	-	1,000
Contingencies				27,000
Total				$ 134,000
Total, joint-use lands				$1,617,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Lands and Damages, Specific-Use Lands				
Fee acquisition				
Recreation lands	Acre	2,000	$140	$280,000
Downstream access	Acre	15	40	600
Acquisition costs	Job	1	-	15,000
Contingencies				73,400
Total, specific-use lands				$369,000
Total lands and damages				$1,986,000
Relocations				
Roads				
State routes 15 & 335	Job	1	-	$1,476,000
County roads	Job	1	-	1,895,000
Total, roads				$3,371,000
Utilities				
Power lines	Job	1	-	$ 47,000
Telephone lines	Job	1	-	51,000
Total, utilities				$ 98,000
Cemeteries				
Bethany church	Job	1	-	40,000
Sub-total, relocations				$3,509,000
Contingencies (25%)				891,000
Total relocations				$4,400,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
		Reservoir Clearing		
Woodland	Acre	4,500	$115	$517,500
Brushland and farmland	Acre	1,940	25	48,500
Buildings	Each	35	200	7,000
Archeological and historical survey and salvage	Job	1	L.S.	20,000*
Sub-total				$593,000
Contingencies				123,000
Total, reservoir clearing				$716,000
		Dike		
Stripping	Cu Yd	500	0.40	200
Unclassified excavation	Cu yd	400	0.60	200
Impervious compaction	Cu yd	5,400	0.10	500
Riprap, dumped	Cu yd	1,500	7.00	10,500
Sub-total, dike				$ 11,400
Contingencies (25%)				2,600
Total, dike				$ 14,000

*** To be funded by Dept. of Interior in A E & D stage.**

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Earth Non-Overflow Section				
Stripping	Cu yd	4,000	$0.40	$ 1,600
Unclassified	Cu yd	54,400	0.50	27,200
Borrow	Cu yd	149,200	0.40	59,700
Weathered rock	Cu yd	6,150	0.60	3,700
Impervious compaction	Cu yd	238,500	0.10	23,800
Riprap, dumped	Cu yd	9,130	7.00	63,900
Chimney drain (sand)	Cu yd	4,300	2.25	9,700
Drain blanket material (sand)	Cu yd	2,100	2.00	4,200
Toe drain				
Sand	Cu yd	400	2.25	900
Crushed stone	Cu yd	200	7.50	1,500
Grout hole drilling	Lin ft	4,080	3.50	14,300
Pressure grouting	Cu ft	2,040	2.00	4,100
Sub-total, earth non-overflow section				$214,600
Contingencies (25%)				53,400
Total, earth non-overflow section				$268,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
		Concrete Non-Overflow Section		
Stripping	Cu Yd	3,000	0.40	$ 1,200
Clearing and Grubbing	Acre	50	300.00	15,000
Unclassified	Cu Yd	32,000	0.40	12,800
Weathered rock	Cu Yd	36,900	0.50	18,400
Solid rock	Cu Yd	8,700	1.50	13,000
Foundation preparation	Sq Yd	5,200	3.50	18,200
Grout Hole Drilling	Lin Ft	3,600	3.50	12,600
Pressure Grouting	Cu Ft	1,800	2.00	3,600
Concrete, mass	Cu Yd	90,400	20.00	1,808,000
Reinforcing steel	Lbs	27,100	0.14	3,800
Sub-Total, Non-Overflow Section				$1,906,600
Contingencies (25%)				475,400
Total, Non-Overflow Section				$2,382,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
		Concrete Overflow Section		
Stripping	Cu Yd	6,550	0.40	$ 2,620
Unclassified	Cu Yd	62,300	0.40	24,920
Weathered Rock	Cu Yd	27,300	0.50	13,650
Solid Rock	Cu Yd	11,900	1.50	17,850
Foundation Preparation	Sq Yd	4,000	3.50	14,000
Grout Hole Drilling	Lin Ft	720	3.50	2,520
Pressure Grouting	Cu Ft	360	2.00	720
Concrete				
Mass (Spillway)	Cu Yd	14,800	20.00	296,000
Piers	Cu Yd	1,660	40.00	66,400
Walls (Reinforced)	Cu Yd	4,660	50.00	233,000
Slab	Cu Yd	4,200	25.00	105,000
Reinforcing Steel	Lbs	682,600	0.14	95,564
Crest Gates (25' x 30')	Ea	3	45,000.00	135,000
Stop Logs	Job	1	-	24,000
Spillway Bridge	Sq Ft	2,280	12.00	27,360
Diversion and care of water	Job	1	-	60,000
Subtotal, Concrete Overflow Section				$1,118,604
Contingencies (25%)				279,396
Total, Concrete Overflow Section				$1,398,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Outlet Works				
Sluice gates (4' x 4')	Ea	2	$15,000	$ 30,000
Sub-total, outlet works				$ 30,000
Contingencies (25%)				8,000
Total, outlet works				$ 38,000
Access Roads				
Access roads	Job	1	-	$200,000
Total, dam and appurtenances				$4,300,000
Buildings, Grounds and Utilities				
Buildings, grounds and utilities	Job	1	-	$ 125,000
Permanent Operating Equipment				
Permanent operating equipment	Job	1	-	$ 100,000
Wildlife Mitigation				
Habitat improvement (water control gate)	Job	1	L.S.	$ 5,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Recreation				
Initial Increment				
Picnic units	Ea	11	$ 2,160	$24,000
	Ea	10	1,880	19,000
Picnic shelters	Ea	1	11,610	12,000
	Ea	-	11,050	-
Boat launching ramps	Ea	2	36,000	72,000
and facilities	Ea	2	30,400	61,000
Camping units	Ea	40	1,500	60,000
	Ea	39	1,250	49,000
Swimming				
Beach	Sq ft	38,000	1.25	47,000
Parking units	Ea	95	350	33,000
Parking units	Ea	95	280	27,000
Change house	Ea	3	15,000	45,000
Trails and walks	Mile	6	7,900	48,000
Water supply units	Ea	38	1,200	46,000
Sanitation units	Ea	9	9,500	86,000
Landscaping and signs	Job	1	L.S.	6,000
Roads	Mile	1	65,000	65,000
	Mile	1	30,000	30,000
Playground equipment and site improvement	Job	1	L.S.	20,000
Fishing facilities includes ramps and parking spaces	Job	1	L.S.	121,000
Fish and wildlife establishment	Job	1	L.S.	46,000
Sub-total				$917,000
Contingencies				138,000
Total, recreation, initial increment				$1,055,000

TABLE 7-6 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
		Recreation		
Future Increment				
Picnic units	Ea	42	$ 2,160	$ 91,000
	Ea	43	1,880	81,000
Picnic shelters	Ea	2	11,610	23,000
	Ea	2	11,050	22,000
Boat launching ramps	Ea	9	36,000	324,000
and facilities	Ea	8	30,400	243,000
Camping units	Ea	157	1,500	236,000
	Ea	158	1,250	197,000
Swimming				
Beach	Sq ft	151,850	1.25	190,000
Parking units	Ea	380	350	133,000
Parking units	Ea	379	280	106,000
Change house	Ea	1	20,000	20,000
Trails and walks	Mile	24	7,900	190,000
Water supply units	Ea	150	1,200	180,000
Sanitation units	Ea	35	9,500	332,000
Landscaping and signs	Job	1	L.S.	23,000
Roads	Mile	0.5	65,000	33,000
	Mile	0.5	30,000	15,000
Playground equipment and site preparation	Job	1	L.S.	60,000
Fishing facilities Includes ramps and parking spaces	Job	1	L.S.	121,000
Sub-total				$2,620,000
Contingencies				393,000
Total, recreation, future increment				$3,013,000

TABLE 7-7
DETAILED ESTIMATE OF ANNUAL FINANCIAL CHARGES
FOR CURRY CREEK PROJECT

Item	Financial ($1,000)
a. Total Investment Costs	
(1) Initial construction costs	14,292
(2) Interest during construction	697
(3) Investment costs, initial increment	14,989
(4) Investment costs, future recreation increment	3,465
(5) Total Gross Investment	18,454
b. Annual Financial Charges, Initial Increment (100-Year Life)	
(1) Interest on investment	487
(2) Amortization on investment	21
(3) Operating and maintenance and major replacement	
(a) Dam	100
(b) Recreation	
General	25
Fish & Wildlife	17
(c) Mitigation	1
(4) Total initial annual financial charges	651
c. Future Recreation Increment Discounted (100-Year Life)	
(1) Interest on investment	29
(2) Amortization on investment	1
(3) Operating and maintenance and major replacement	45
(4) Total future recreation increment	75
Total Annual Financial Charges	726

TABLE 7-8
DETAILED ESTIMATE OF FIRST COST
DOWNSTREAM FISHERY CURRY CREEK PROJECT, GA.

Item	Unit	Quantity	Unit price	Amount
Lands and Damages:				
Access Sites (Tailwater site & 11-1 acre sites)	acre	15	40	$600
Acquistion Costs	L.S.			7,500
Contingencies				2,000
Total, Lands				10,100
Facilities Cost:				
Tailwater Site	Job	1	L.S.	6,000
River Access Sites	Site	11	1,000	11,000
Contingencies				2,600
Subtotal				19,600
Engineering and Design				1,200
Supervision and Administration				1,800
Total, Facilities Cost				22,600
Cost Downstream Fisheries */				32,700

ANNUAL FINANCIAL CHARGES
DOWNSTREAM FISHERY CURRY CREEK PROJECT, GA.

Total Cost Downstream Fishery	32,700
Interest (.0325)	1,000
Amortization (.00138)	100
Operation and Maintenance	2,400
Total, Financial Charges	3,500

*/ Note: These costs are included in Tables 7-6 and 7-7.

SECTION V - BENEFITS

17. SUMMARY

A categorized summary of benefits accruing to the proposed plan of development for the Curry Creek Project is presented in Table 7-9.

TABLE 7-9
SUMMARY OF BENEFITS
CURRY CREEK PROJECT

Category and Class of Benefits	Annual Benefits - ($1,000)				
	National Account Only	Regional Account Only	National and Regional Account	Total National Account	Total Regional Account
User Benefits					
Flood Control	185		49	234	49
Land Enhancement	15		18	33	18
Water Supply	136		118	254	118
Recreation	184		402	586	402
Total User Benefits	520		587	1,107	587
Expansion Benefits					
Redevelopment		171	67	67	238
Development Wages		3,844	404	404	4,248
Total Expansion Benefits		4,015	471	471	4,486
Total Benefits	520	4,015	1,058	1,578	5,073

18. USER BENEFITS

Benefits accruing to the project are categorized into user benefits and expansion benefits. Benefits to users as evaluated in this report result from water storage for flood control, recreation, and water supply. Evaluation and treatment of damages used to derive flood control benefits are also described in this section.

Extent and Character of Flooded Area

The overflow area studied extends from the Curry Creek site in Jackson County south to the confluence of the North Oconee and Middle Oconee Rivers. Included in the area to be protected are approximately 1,600 acres of agricultural land, 315 acres of land for industrial use, a portion of Athens and a portion of Whitehall. Agricultural production is confined mostly to the wide bottoms in Jackson County.

Flood Damages, General

Data used to develop damage estimates for the North Oconee River are based on field damage surveys conducted in 1966 and 1967. For study purposes, damages were related to a control gage located within the city limits of Athens. From field surveys, it was estimated that the 26 May 1966 flood with a natural frequency of 13 years did $85,000 in damages. Average annual damages are shown in Table 7-10.

TABLE 7-10
ESTIMATED AVERAGE ANNUAL DAMAGES
ATHENS AREA, NORTH OCONEE RIVER

Reach and Item	Location	Average Annual Damage*
Reach-Jackson County	Curry Creek Site	
Agricultural	to	
Crop and Pasture	Clarke County Line	$ 27,700
Reach-Clarke County	Jackson County Line	
Urban	to	
Athens and Whitehall	Middle Oconee River	87,500
Total Study Area (current development)		115,200

* 1967 Values

Crop Damage

Present damages occur to 350 acres of crops and pasture. The remaining agricultural land has reverted to brush and low quality hardwood due to frequent flooding. A simple short cut method was used to compute present flood damages to the existing low-value property.

Urban Damage

Field surveys were made of each urban area affected by flooding in the study area. The City Engineer of Athens, the Clarke County Engineer and local industrial executives furnished information pertaining to valuations and estimates of damages for various stages of flooding. Flood damages caused by the recent flood of 26 May 1966 were utilized in constructing a stage damage curve. The Frequency-Damage Method for flood damage appraisals was used in estimating urban damage with and without the project.

Flood Control Benefits

Present flood control benefits are measured as the difference in flood damages with existing development under present conditions of flooding and those to existing development with the project in operation. Benefits will also accrue to the proposed project as a result of normal future development expected in the flood plain in the absence of the project. Growth in the area was estimated on the basis of projected population. Benefits were further adjusted to reflect added values to the properties and contents in the overflow area. These projections were made on the basis of approximately 2 1/2 percent compounded annually. A summary of flood control benefits is presented in Table 7-11.

TABLE 7-11
SUMMARY OF FLOOD CONTROL BENEFITS
CURRY CREEK RESERVOIR PROJECT

Reach: Damsite to Middle Oconee River

	Benefits
Present Development*	$105,600
Future Development**	128,300
Total	$233,900

* Includes all benefits estimated.

** Annual equivalent of added values resulting from future economic growth in area.

Enhancement Benefits

Land enhancement benefits for the flood plain protected by the proposed project include benefits from the potential use of the land for agriculture and industrial use. Of the 1,600 acres of agricultural land to be protected, an estimated 1,300 acres will be restored and developed to crops and pasture yielding $35,400 in benefits. One half of the benefits ($17,700) will be shown as damage reduction benefits to allow for the land that has been removed from agriculture use in recent years due to frequent flooding. An additional $15,200 in benefits is the result of 315 acres being protected for industrial development. After project installation floods equal to the flood of 26 May 1966 will have a 75-year frequency in the Athens area.

General Recreation Benefits

An analysis has been made of the general recreation potential of the proposed Curry Creek Reservoir. Initial visitation is estimated at 300,000 annually, increasing ultimately to 1,500,000. With an assigned benefit value of $1.25 per visitor day, average annual equivalent benefits for general recreation are estimated at $438,000.

The annual visitation will increase over the project economic life from 300,000 visits to 1,500,000 in a delayed gorwth pattern and the average annual equivalent of benefits was discounted with the factor .2335.

Fish and Wildlife Benefits

The increased Fish and Wildlife recreational visitation and benefits accruing thereto, for the Curry Creek Reservoir have been evaluated for the project. The benefits including those from the downstream fishery amount to $148,000. A summary of the benefits from the 12-mile downstream fishery to Athens is shown in Table 7-12.

TABLE 7-12
SUMMARY OF BENEFITS
DOWNSTREAM FISHERY - CURRY CREEK PROJECT, GA.

Category and class of benefits	Annual Benefits (Dollars)				
	National Account Only	Regional Account Only	National and Regional Account	Total National Account	Total Regional Account
Recreation	1,200	0	2,200	3,400	2,200
Redevelopment	0	283	348	348	631
Total	1,200	283	2,548	3,748	2,831
Total, regional plus national benefits					4,031

Note: These benefits are included in Table 7-13.

Water Supply Benefits

Based on benchmark population projections for the area that could be served by a water supply storage at the Curry Creek Reservoir Project, a need for 60 mgd will exist by the year 2020 (See Table 7-1). This need would require a storage of 27,000 acre feet. City officials of Athens and Jefferson foresee a need of 35 and 2 mgd, respectively. The remaining 23 mgd would be available to satisfy needs which are expected to occur in nearby rural and urban areas. Benefits credited to the water supply storage are based on the most economical alternative for acquiring an equal amount of water. The alternative cost for water supply (Section VI) was estimated to be $254,000 annually. The annual alternative cost is credited as benefits to water supply. These and other user benefits are shown in Table 7-13.

TABLE 7-13
SUMMARY OF USER BENEFITS
CURRY CREEK PROJECT

Item	Benefits ($1,000)
Flood Control:	
Present	106*
Future	128
Land Enhancement	33**
Recreation:	
General	438
Fish and Wildlife	148
Water Supply	254
Total Benefits	1,107

* Includes one-half agricultural enhancement benefits amounting to $17,700.

** $17,700 (one-half agricultural enhancement benefits) + $15,200 industrial development sites.

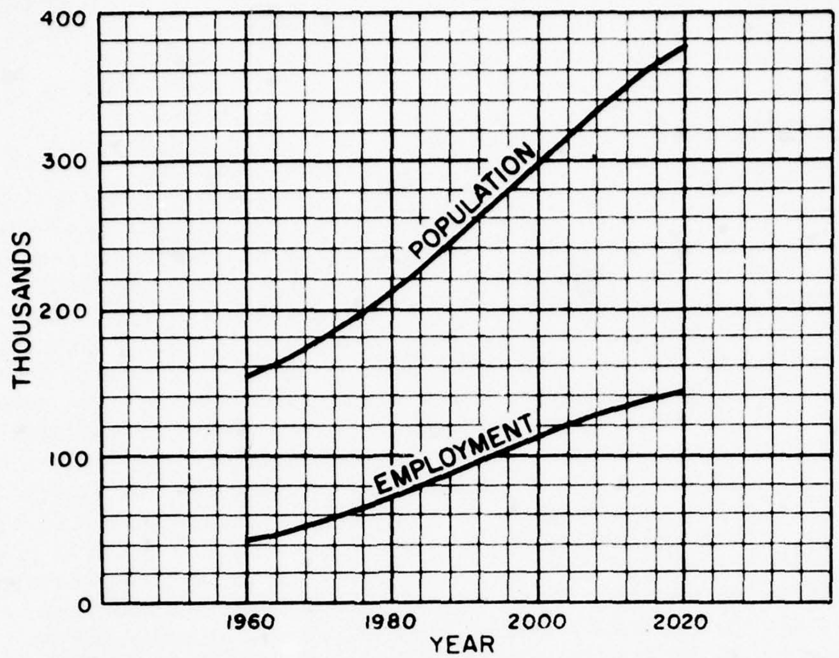
19. EXPANSION BENEFITS

The Curry Creek Reservoir is formulated to provide flood control in the area extending downstream to Athens and beyond, to supply water for identified needs downstream to Athens and to provide a facility capable of supplying about 1.6 million visitor days of opportunity for water related outdoor recreation. Increased income flows can be attributed to each of these services and to their joint effects. The flood control measures will allow increased intensity of flood plain use as the urbanizing influence of growth in Athens continues. The water supply features of the project will allow increased employment in Jefferson, Athens, and in intervening areas. Expenditures by persons utilizing the recreational facilities of the project will increase income flows in the region.

There are certain measurement problems in estimating regional income immediately adjacent, but outside the region for which the benefits are to be estimated. While an important level of interaction exists between the economy of Athens and the adjacent counties in Appalachia, the precise delineation between those income gains which are entirely Appalachian regional gains and other gains is difficult to attain. On the other hand, the employment of otherwise unemployed or underemployed labor is the most easily defined net gain either from the national or from the regional standpoint. Since the absolute level of unemployment is comparatively low in the laborshed contributing to the Athens urban area, the expansion benefits analysis has been limited to those employment activities which would clearly be attracted to the area by the combination of the attributes of the local economy and the presence of adequate water services.

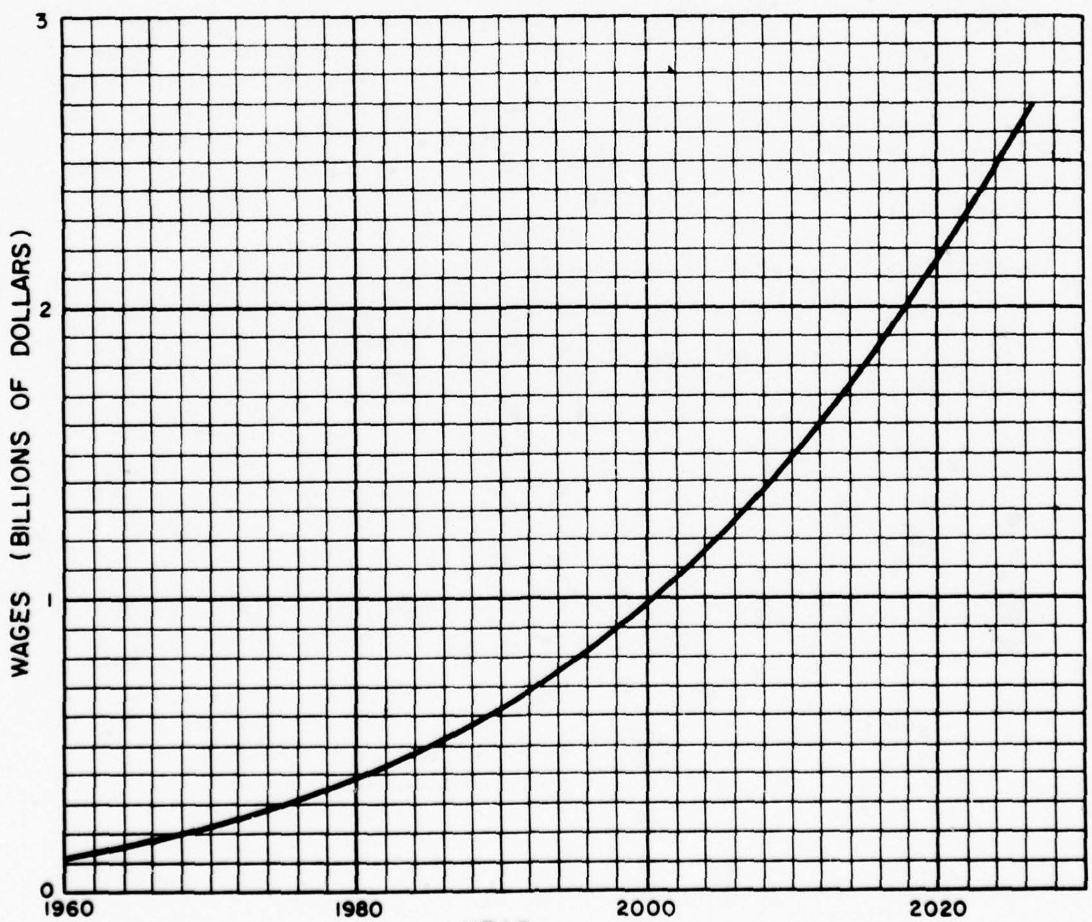
An analysis of the textile and poultry industries, which are important to the economy of this area, indicates that introduction of a chicken processing facility and a textile finishing plant would complement the existing industrial mix. These firms could utilize inputs from local industry and envelop potential scale economies of agglomeration. The analysis of labor requirements and labor supply indicated that these two activities could utilize the existing unemployed resources of the area. Thus additional analysis of potential expansion effects did not appear warranted in the context of the goal of increasing Appalachian employment.

Wages resulting from benchmark population and employment (See Figures 7-1 and 7-2) reflect the response of total development for the study area. Public development to accomplish benchmark growth includes interstate highways, airport facilities, vocational schools, libraries, water treatment plants, and sewerage facilities. These are in addition to the Curry Creek water resources development project. However, for the purposes of this Report, developmental expansion benefits measured in terms of salaries, wages, and profit on industrial and commercial investment are limited to the provision of water supply. Under the provision of Public Law 87-27, the cost of labor used in project construction is credited as redevelopment expansion benefits. Secondary costs will be nominal.



FUTURE BENCHMARK POPULATION AND EMPLOYMENT
IN CURRY CREEK PROJECT AREA

Figure 7-1



WAGES FOR BENCHMARK EMPLOYMENT IN PROJECT AREA

Figure 7-2

Developmental Expansion Benefits

The national account reflects the wages and salaries paid to people who would otherwise be unemployed. Wage payments assigned to the national account are net efficiency gains for the Nation and are attributable to the employment of the otherwise unemployed persons in the developing economy stimulated by investment in the project area. The regional account is to reflect wages paid to all workers whose jobs are generated by the project irrespective of where they are located. In addition to salaries and wages, the national and regional accounts are credited with a profit and entrepreneurship factor computed annually as 10 percent of the industrial and commercial investment. With the assurance of an adequate supply of water, several industrial plants are expected to locate in the area, thus taking advantage of efficiency of production. The installation of a poultry plant and a textile plant on which expansion benefits were evaluated, will involve an investment of approximately $8,750,000. These plants, along with service and recreation, will provide wages and salaries that may be computed as expansion benefits. Tables 7-14 and 7-15 contain more detailed information.

An adjustment of total wage and salary payments made to persons employed from the area for assignment to the National Account has been made. The adjustment ranges from 50 percent of all wages assigned to the National Account during the first year down to 0 percent 20 years in the future. No wages will be assigned to the National Account thereafter. The adjustment depicting the declining wage flow is shown in Figure 7-3.

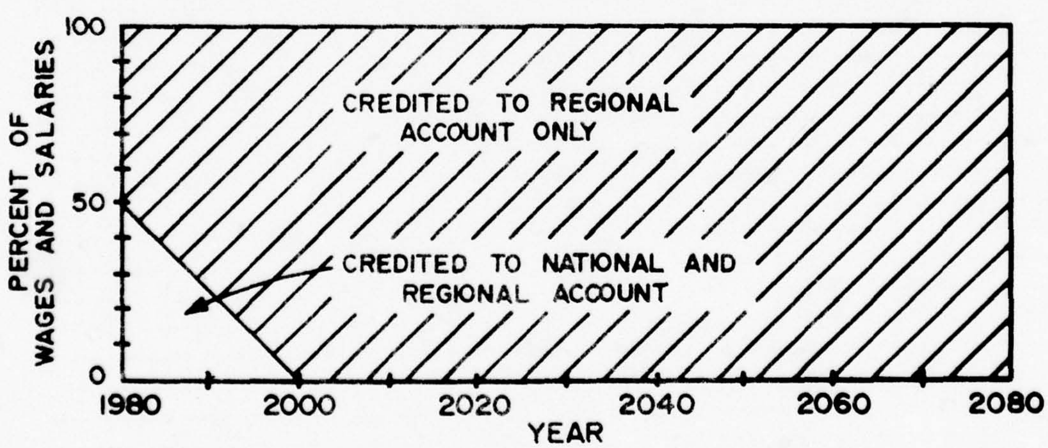


FIGURE 7-3. WAGE AND SALARY ADJUSTMENT FOR NATIONAL ACCOUNT.

The national account shows only the wages paid to local semi-skilled and unskilled workers that are unemployed. Wages and salaries paid to workers in the executive, professional and skilled categories are included in the regional account since they are presently employed.

The following computations are shown as the derivation of expansion benefits:

Regional Expansion Benefits

$4,916,000 from Table 7-15
.86406 10 yr. log factor 3 1/4%
$4,916,000 x .86406 = $4,248,000
238,000 from Table 7-20
238 + 4248 = $4486 as shown in Table 7-21

National Expansion Benefits

$2,437,000 (Total semi and unskilled wages - Table 7-15)
0.1657 (Compound interest adjustment to account for 10 yr. log and cutoff to zero in 20 years - 3 1/4% interest)
404,000 Annual Developmental Benefits (rounded)
67,000 Redevelopmental
$471,000 Annual Expansion Benefits - National - Table 7-21

TABLE 7-14
PERSONNEL REQUIRED FOR EXPANSION RESULTING FROM INSTALLATION OF CURRY CREEK PROJECT

Type	Poultry Plant	Textile Plant	Service	Recreation	Total
Executive	4	24	21	0	49
Professional	4	30	25	0	59
Skilled	24	75	73	0	172
Semi-skilled	24	75	73	28	200
Unskilled	144	96	178	64	482
Total	200	300	370	92	962*

* Analysis of labor force in project area showed 915 unemployed above the national level. The unemployed above the national level was placed in the semi-skilled and unskilled categories. Only the 682 persons wages will be used for computing national expansion benefits.

TABLE 7-15
DEVELOPMENTAL EXPANSION BENEFITS
FROM SALARIES AND WAGES - ANNUALLY

Type	Personnel Required	Annual* Earnings (Benefits)	Total Earnings (Benefits)
Executive	49	$14,000	$ 686,000
Professional	59	11,000	649,000
Skilled	172	6,650	1,144,000
Semi-skilled	200	4,160	832,000
Unskilled	482	3,330	1,605,000
Total	962	--	4,916,000

* This information resulted from interviews with representatives from industry, Chambers of Commerce, and planning commissions.

Unemployed in Project Area

Table 7-16 presents unemployment estimates in the Curry Creek project area. Additional information regarding the labor situation is contained in the following excerpt taken from the Athens area Chamber of Commerce economic report published May 1966: "Within the Athens labor market area (Barrow, Clarke, Greene, Jackson, Madison, Morgan, Oconee, Oglethorpe, and Walton Counties) approximately 5,000 persons are currently available, according to conservative estimates made by the Georgia Department of Labor in January 1966. Provided attractive job opportunities are offered, some 1,900 white men, 1,700 white women, 800 Negro men, and 800 Negro women could be considered. The supply comprises farm surplus workers, marginal farm operators, school graduates and dropouts, housewives and the currently unemployed. This pool is largely unskilled but trainable; it contains some persons with previous experience in textile and garment manufacture."

Income and Earnings

Family income as shown in Table 7-17 reflects the seriousness of underemployment in the Curry Creek project area. With restraints removed allowing economic growth to improve, annual earnings per worker are expected to advance from a low of $3,103 in 1960 to $14,915 by year 2020. Estimates of benchmark employment and wages through year 2020 are shown in Table 7-18.

TABLE 7-16
UNEMPLOYED IN CURRY CREEK PROJECT AREA - 1965

County	Reported by State Department of Labor	Reported through Chamber of Commerce Survey*	Total
Banks	90	109	199
Barrow	240	248	488
Clarke	480	1,174	1,654
Hall	770	1,022	1,792
Jackson	270	338	608
Madison	170	192	362
Total	2,020	3,083	5,103

* Not included in Department of Labor estimates.

TABLE 7-17
FAMILIES WITH INCOME UNDER $3,000 - 1960

County	Percent of Total
Banks	46.1
Barrow	41.3
Clarke	31.7
Hall	34.5
Jackson	42.0
Madison	55.0
U.S.	21.4
Georgia	35.6

TABLE 7-18
CURRY CREEK PROJECT AREA
ESTIMATE OF BENCHMARK EMPLOYMENT AND WAGES

Year	Population	Population Per Worker	Employment	Earnings Per Worker	Total Wages (Millions $)
1960	145,829	3.38	43,145	$3,103	134
1980	217,130	2.84	76,454	5,006	383
2000	280,030	2.60	107,704	9,135	986
2020	376,630	2.58	145,981	14,915	2,177

Redevelopment Expansion Benefits

Under the provisions of Public Law 87-27, the cost of labor used in project construction is credited as redevelopment project benefits. Analysis of construction cost of various reservoirs indicates labor cost to be 20 percent of project construction costs (excluding lands and damages). Further analysis was made to determine the degree of skill required in project construction and what number of these labor skills could be furnished from the area where the unemployment rate is classified as substantial and persistent. The results of these studies are presented as a part of Tables 7-19 and 7-20.

TABLE 7-19
LABOR SKILL REQUIRED FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF MULTIPLE PURPOSE PROJECT
CURRY CREEK

Category	Labor Required (Percent)	Supplied Locally (Percent)	Redevelopment Factor National Account	Redevelopment Factor Regional Account
Construction				
Skilled	59	20	0.12	0.59
Semi-skilled	24	50	0.12	0.24
Unskilled	17	100	0.17	0.17
Total	100		0.41	1.00
O and M				
Skilled	20	20	0.04	0.20
Semi-skilled	50	50	0.25	0.50
Unskilled	30	100	0.30	0.30
Total	100		0.59	1.00

TABLE 7-20
REDEVELOPMENT BENEFITS ($1,000)
CURRY CREEK PROJECT

Category	Expenditure	Labor Costs*	Annual Redevelopment Benefits National Account	Annual Redevelopment Benefits Regional Account
Construction				
Initial	12,306	2,461	34	83
Future	3,465	693	10	23
Annual Operation and Maintenance				
Initial	143	100	17	100
Future	45	32	6	32
Total Benefits			67	238

*Labor cost is estimated to be 20 percent of construction costs less lands and damages; 70 percent of operation and maintenance expenditures.

20. INTANGIBLE

Intangible damages are not adaptable to monetary measurement; however, they are of considerable importance on the North Oconee River. A car carrying three adults and seven children went into the flooded river on 28 June 1963 with only two surviving. There have been other serious accidents in the area during periods of extreme flooding. Although the loss of lives was not attributed to the flood, it is reasonable to assume that not all of the eight people would have drowned had the river not been at flood stage when the accident occurred.

21. INDICES OF PERFORMANCE

One index of performance which is related to economic efficiency can be evaluated by reliance upon the conventional ratio of benefits to cost generally developed for water resources projects. The numerator contains annual user benefits plus those employment benefits contributable to direct construction and operation of the water project (redevelopment benefits). The denominator is the annual cost of water project.

TABLE 7-21
SUMMARY OF BENEFITS FOR PERFORMANCE INDICES
CURRY CREEK RESERVOIR, GA. ($1,000)

Item	National	Regional
User	1,107	587
User and Redevelopment	1,174	825
Expansion	471	4,486

Such an index computed below expresses the minimum index of performance in regard to national income.

$$\frac{1,174}{726} = 1.6$$

Another index of performance gives a relative measure of the contribution that the Curry Creek Reservoir development would make to the objective of expanding employment in the Appalachian Region. The numerator consists of increased wage payments for construction and operation of the water project plus wage and salary flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{4,486}{1,022} = 4.4$$

22. COST ALLOCATIONS

General

Cost allocations are made to provide a basis for cost sharing. The Separable Cost-Remaining Benefits Method was utilized to allocate the costs. Expansion benefits were introduced as a purpose.

Alternative Costs

The costs of the most efficient single purpose alternative projects (Shown in Table 7-22) were utilized as benefits limits. Location and features of these projects are described below.

a. Flood Control. The most efficient alternative method of providing an equivalent degree of flood protection for the City of Athens, the community of Whitehall and the agricultural land in Clarke and Jackson Counties would be a single-purpose reservoir at the Curry Creek site.

b. Water Supply. A single-purpose reservoir at the Curry Creek site would provide the most efficient alternative for water supply.

c. Recreation. State parks provide a significant number of water-related outdoor recreation opportunities. The costs incurred by the State parks systems for provision of generally equivalent recreation opportunities are utilized as appropriate alternative costs.

d. Expansion. Alternative costs for expansion are assumed equal to the benefits.

Separable Costs

Separable costs are those additional costs incurred in adding each purpose to the project. They are derived by computing the savings which would accrue if each purpose were individually omitted from the project while benefits to the other purposes are maintained. A graphic portrayal of the project features utilized in cost allocation studies is presented in Figure 7-4.

a. Flood Control. A reservoir less flood control storage with necessary adjustments to spillway crest elevation would provide equivalent benefits for the other purposes.

b. Water Supply. There are no separable costs attributable to water supply. Any cost found directly attributable to water supply during the preparation of design memoranda will be allocated to this purpose.

c. Recreation. Specific use recreation lands and facilities were omitted. The resulting project would provide equivalent benefits for the other purposes.

d. Expansion. No separable costs are attributable to expansion.

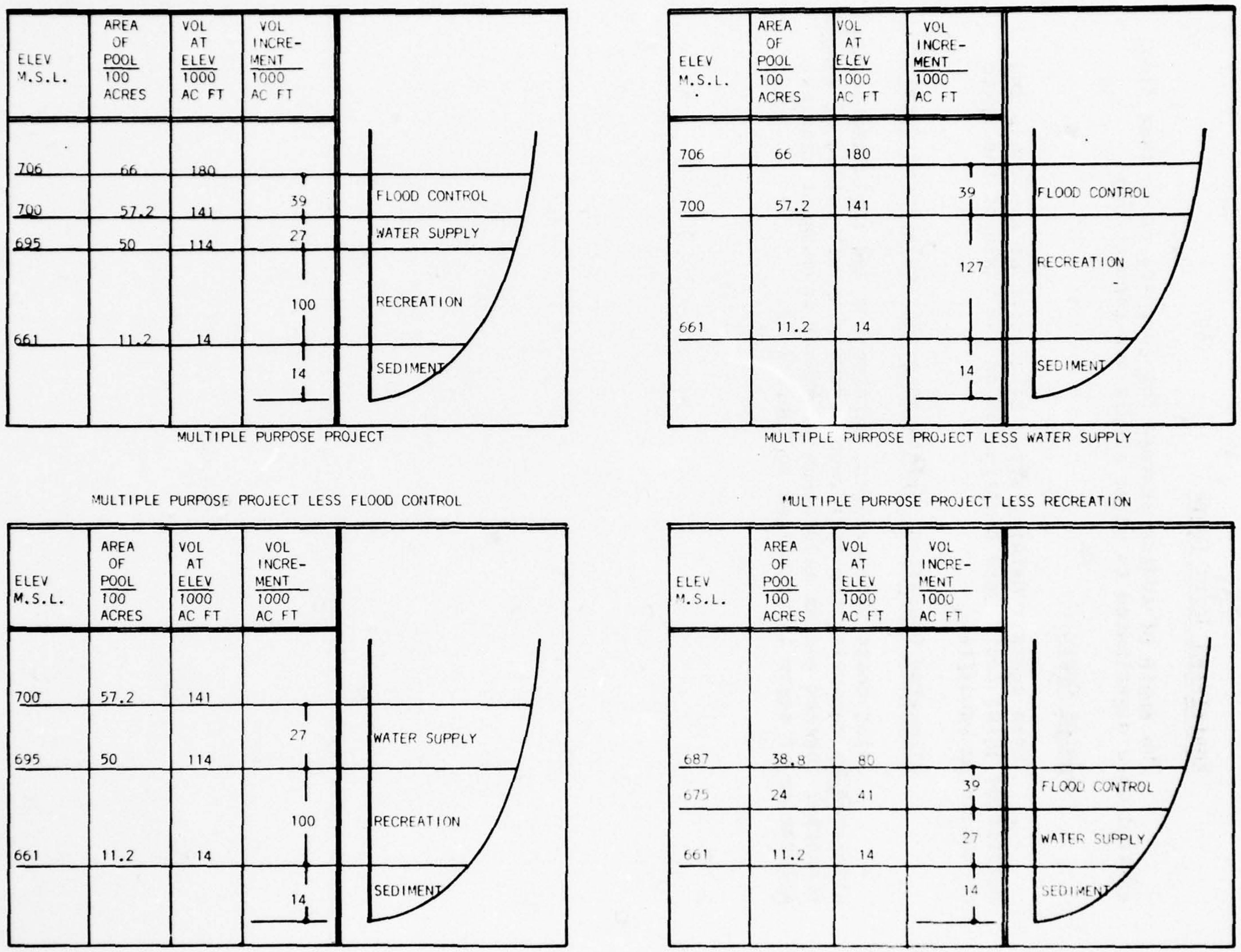
TABLE 7-22

COST ALLOCATION STUDIES
CURRY CREEK PROJECT, GEORGIA
SUMMARY OF COSTS ($1,000)

Item	Multiple-Purpose Reservoir: Recreation Lands and Facilities	Multiple-Purpose Reservoir: Regional Income Expansion	Multiple-Purpose Reservoir: Joint Use Lands Facilities	Multiple-Purpose Reservoir: Total Costs	Alternate Single Purpose Projects: Flood Control	Alternate Single Purpose Projects: Water Supply	Alternate Single Purpose Projects: Recreation	Multiple-Purpose Project Less: Flood Control	Multiple-Purpose Project Less: Water Supply	Multiple-Purpose Project Less: Recreation	Multiple-Purpose Project Less: Regional Income Expansion
Construction First Costs											
Project costs											
Lands and damages	369		1,617	1,986				1,761			1,986
Relocations			5,060	5,060				4,232			5,060
Reservoir and pool preparation			823	823				821			823
Dam and appurtenances			4,945	4,945				4,210			4,945
Recreation facilities	1,213			1,213				1,213			1,213
Buildings, grounds and utilities			144	144				144			144
Permanent operating equipment			115	115				115			115
Mitigation lands development			6	6				6			6
Total, initial	1,582		12,710	14,292	9,658	6,255		12,502	14,292	9,698	14,292
Future recreation facilities	3,465			3,465				3,465	3,465		3,465
Total project costs	5,047		12,710	17,757				15,967	17,757		17,757
Developmental costs		8,750		8,750				8,750	8,750	8,750	
Total construction costs	5,047	8,750	12,710	26,507	9,658	6,255		24,717	26,507	18,448	17,757
Investment Costs											
Project											
Initial construction costs	1,582		12,710	14,292	9,658	6,255		12,502	14,292	9,698	14,292
Interest during construction	77		620	697	471	292		609	697	473	697
Investment cost, initial increment	1,659		13,330	14,989	10,129	6,547		13,111	14,989	10,171	14,989
Future recreation facilities	3,465			3,465				3,465	3,465		3,465
Interest during construction											
Investment cost, future increment	3,465			3,465				3,465	3,465		3,465
Developmental		8,750		8,750				8,750	8,750	8,750	
Total investment costs	5,124	8,750	13,330	27,204	10,129	6,547		25,326	27,204	18,921	18,454
Annual Financial Charges											
Initial Increment											
Interest and amortization	56	296	452	804	343	222	111	741	804	641	508
Operation and maintenance						32					
Recreation	42		1	42			80	42	42		42
Dam and Reservoir 1/			101	101	75			101	101	101	101
Total, initial increment	98	296	553	947	418	254	191	884	947	742	651
Future Increment (discounted)											
Interest and amortization	30			30			60	30	30		30
Operation and maintenance and major replacement	45			45			90	45	45		45
Total, future increment	75			75			150	75	75		75
Total annual financial charges	173	296	553	1,022	418	254	341	959	1,022	742	726

1/ Includes $1,000 for Mitigation Lands O&M.

Figure 7-4
PROJECT FEATURES
COST ALLOCATION STUDIES
CURRY CREEK PROJECT, GEORGIA



Restricted Joint Costs

The costs of adding storage for purposes other than flood control were distributed to water supply and recreation.

Joint Costs

Those costs remaining after allocation of separable and restricted joint costs were distributed on the basis of the ratio of remaining benefits.

Allocated Operation, Maintenance and Replacement Costs

Joint costs of operation, maintenance and replacement were allocated by computing the difference between an allocation of annual financial charges and an allocation of annual investment charges. Allocation of costs is presented in Table 7-23.

TABLE 7-23

CURRY CREEK PROJECT
ALLOCATION OF COSTS ($1,000)

Item	Flood Control	User Benefits: Water Supply	User Benefits: Recreation	Regional Expansion Effects	Total
1. Benefits	267	254	586	5,242	-
2. Alternative costs	418	254	341	1,022	-
3. Benefit limits	267	254	341	1,022	1,884
4. Separable costs	63	0	280	296	639
5. Remaining benefits	204	254	61	726	1,245
6. Allocation of restricted costs:					
a. Remaining benefits	-	254	61	-	315
b. Ratio	-	.806	.194	-	1.000
c. Allocated restricted costs 1/	-	23	5	-	28
7. Separable plus allocated restricted costs	63	23	285	296	667
8. Remaining benefits	204	231	56	726	1,217
9. Ratio	.168	.190	.046	.596	1.000
10. Allocated joint costs	60	68	16	211	355
11. Total allocated financial charges	123	91	301	507	1,022

TABLE 7-23 (Cont'd)

Item	User Benefits: Flood Control	User Benefits: Water Supply	Recreation	Regional Expansion Effects	Total
Allocation of Annual Operation, Maintenance Charges and Replacement					
12. Separable OM&R charges	0	0	87	0	87
13. Allocated joint OM&R charges	17	19	5	60	101
14. Total allocated OM&R charges	17	19	92	60	188
15. Annual investment charges	106	72	209	447	834
16. Capitalized investment costs	3,129	2,125	6,169	13,207 2/	24,630
17. Adjustment for discount on future increment	-	-	2,574	-	2,574
18. Total allocated investment costs	3,129	2,125	8,743	13,207	27,204
19. Investment in specific use lands and facilities	-	-	5,124	8,750	13,874
20. Investment in joint-use lands and facilities	3,129	2,125	3,619	4,457	13,330
21. Allocated interest during construction on line 20	146	99	168	207	620
22. Allocated construction costs of joint-use land facilities	2,983	2,026	3,451	4,250	12,710
23. Construction costs of specific-use lands and facilities	-	-	5,047	8,750	13,797
24. Total allocated construction costs	2,983	2,026	8,498	13,000	26,507

TABLE 7-23 (Cont'd)

Item	User Benefits: Flood Control	User Benefits: Water Supply	User Benefits: Recreation	Regional Expansion Effects	Total
25. Construction costs of future increment	-	-	3,465	-	3,465
26. Developmental construction cost	-	-	-	8,750	8,750
27. Project construction cost (initial)	2,983	2,026	5,033	4,250	14,292
28. Total project construction cost	2,983	2,026	8,498	4,250	17,757

1/ Multiple-purpose project 1,022
Less cost of flood control and income expansion 714
Cost of adding water supply and recreation 308
Less assigned separable costs 280
Restricted costs 28

2/ 447 - 296 = 151
151 ÷ .03388 = 4,457
4,457 + 8,750 = 13,207

SECTION VII - COST SHARING

23. GOVERNING LEGISLATION

Apportionment of costs for the Curry Creek Reservoir between Federal and non-Federal interests is made in accordance with the appropriate legislative criteria and summarized in Table 7-24.

TABLE 7-24
APPORTIONMENT OF COSTS BETWEEN
FEDERAL AND NON-FEDERAL INTERESTS*

	Construction Costs ($1,000)			Annual Operation, Maintenance and Replacement Charges ($1,000)		
Item	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Flood Control	2,983	0	2,983	17	0	17
Water Supply	0	2,026	2,026	0	19	19
Recreation	4,469	4,029	8,498	5	87	92
Expansion	4,250	0	4,250	60	0	60
Total	11,702	6,055	17,757	82	106	188

* Development costs are not included.

24. APPORTIONED COSTS

Flood Control

All costs allocated to flood control in the multiple-purpose project are apportioned to the Federal Government according to applicable flood control legislation. The effects of the project will determine the extent to which 53 farms, several industrial plants, and other businesses will expand their operations.

Water Supply

All costs allocated to water supply are apportioned to non-Federal interests according to the Water Supply Act of 1958 (PL 85-500). Water supply costs not contracted for initially will be borne by the Federal Government until such time, within the requirements of the Water Supply Act of 1958 (PL 85-500), local interests are required to pay for this additional water.

Recreation

The separable costs associated with recreation development of the reservoir and the designated recreation areas are divided between Federal and non-Federal interests on a 50-50 basis. Non-Federal interests are apportioned all operation and maintenance costs associated with this feature in accordance with the Federal Water Projects Recreation Act (PL 89-72). Derivation of the apportionment of recreation costs between Federal and non-Federal interests is presented in Table 7-25.

TABLE 7-25
APPORTIONMENT OF RECREATION COSTS

Item	($1,000)
Cost of Multiple-Purpose Project	17,757
Cost of Multiple-Purpose Project less Recreation	9,698
Separable Costs of Recreation	8,059
Lands	369
Facilities	4,678
Storage	3,012
Cost Sharing (Separable)	
Federal	4,030
Non-Federal	4,029

Sub-Allocation Recreation Costs

Recreation Category	Benefits ($1,000)	Ratio	Allocated Costs ($1,000)
General	438	0.747	6,348
F&WL	148	0.253	2,150
Total	586	1.000	8,498

Expansion

Costs allocated to regional income expansion have been apportioned to the Federal Government in keeping with the objective of the Appalachian Regional Development Act of 1965 (PL 89-4).

25. STATE AND LOCAL ASSURANCES

Cost sharing by non-Federal interests would be required, as indicated in Table 7-24, for the project costs incurred in providing facilities for the water supply and recreation goods and services of the Curry Creek Reservoir project.

The State of Georgia has requested that the Corps of Engineers include water supply and recreation storage and facilities in the multi-purpose Curry Creek Reservoir project for the development of the water resources of Georgia (See Figures 7-5 and 7-6).

The Cities of Athens and Jefferson, by resolutions passed by their respective councils, have requested reservation of 15,700 and 900 acre feet of water supply storage in the conservation pool of Curry Creek Reservoir (See Figures 7-7 and 7-8).

Executive Department
Atlanta

Lester Maddox
GOVERNOR

Thomas T. Irvin
EXECUTIVE SECRETARY

June 14, 1968

Colonel William L. Barnes
District Engineer
Savannah District
Corps of Engineers
P. O. Box 889
Savannah, Georgia 31402

Dear Colonel Barnes:

Reference is made to my letter of May 27, 1968, indicating interest in the Curry Creek Project. I take this opportunity to re-emphasize our desire to cooperate with the Corps of Engineers in the development of the water resources of Georgia.

Continuing expansion of recreational opportunity is a prevalent and vital need affecting the future well being of our society. Since the needs of the people are our primary concern, it is the intent of the State to participate financially in that portion of the Curry Creek Dam and Reservoir Project cost allocated to recreation in accordance with legislation in effect and to the degree that is compatible with financial capability of the State at the time of project construction.

With kindest personal regards, I am

Sincerely,

Lester Maddox
Governor

Figure 7-5

Executive Department
Atlanta

Lester Maddox
GOVERNOR

Thomas T. Irvin
EXECUTIVE SECRETARY

June 14, 1968

Colonel William L. Barnes
District Engineer
Savannah District
Corp of Engineers
P. O. Box 889
Savannah, Georgia 31402

Dear Colonel Barnes:

Reference is made to my letter of May 27, 1968, indicating interest in the Curry Creek Project. I take this opportunity to re-emphasize our desire to cooperate with the Corps of Engineers in the development of the water resources in Georgia.

The dependable water supply provided will enable the six-county area served by the project to continue toward greater economic growth. Since economic expansion is one of our State goals, it is the intent of the State to participate financially in the unreserved portion of storage in the Curry Creek Dam and Reservoir Project allocated to water supply in accordance with the legislation in effect, and to the degree that is compatible with financial capability of the state at the time of project construction.

With kindest personal regards, I am

Sincerely,

Lester Maddox
Governor

Figure 7-6

AD-A041 393 CORPS OF ENGINEERS CINCINNATI OHIO F/G 8/6

DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

SEP 69

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5 OF 5

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7-77

RESOLUTION ON LOCAL COOPERATION

A RESOLUTION REQUESTING THE FEDERAL GOVERNMENT TO INCLUDE IN ITS PLANNING FOR THE CURRY CREEK PROJECT, PROVISIONS FOR STORAGE FOR WATER SUPPLY

WHEREAS, the Corps of Engineers, U. S. Army, is making a study of a proposed reservoir project on North Oconee River in Jackson County, Georgia, to provide flood control storage and other water-related uses; and

WHEREAS, under the Water Supply Act of 1958, water supply storage may be included for present or anticipated future demand or need for municipal or industrial water; and

WHEREAS, the City of Athens is in need of an additional source of water for municipal and industrial expansion, and is aware of the provisions of the Water Supply Act of 1958 requiring payment by local interest of a portion of the construction costs and a portion of operational and maintenance costs in projects of this nature; and

WHEREAS, the City is vitally interested in the proposed project and desires that a storage be set aside for water supply for the City of Athens.

NOW, THEREFORE, BE IT RESOLVED that the City of Athens hereby requests the Federal Government to include in its planning for the Curry Creek project, provisions for storage of 15,700 acre-feet for water supply under authority of the Water Supply Act of 1958; said storage to be sufficient to ultimately provide 35 million gallons per day.

BE IT FURTHER RESOLVED, that the City of Athens hereby pledges to fully cooperate with the Federal Government in the development of plans for the Curry Creek project. It is understood that payment for such storage for water supply could be within a period of time which will permit paying out the costs allocated to water supply within the life of the project, but in no event to exceed fifty (50) years after the date on which the project is first used for the storage of water for future water supply purposes; and upon approval of construction of the project by Congress or when the Government's plans are completed, a firm determination as to the extent the City will participate with the Federal Government in the project will be made.

PASSED BY THE CITY COUNCIL OF THE CITY OF ATHENS, this the

21 day of May, 1968.

/s/ Julius F. Bishop
MAYOR

Figure 7-7

RESOLUTION ON LOCAL COOPERATION

A RESOLUTION REQUESTING THE FEDERAL GOVERNMENT TO INCLUDE IN ITS PLANNING FOR THE CURRY CREEK PROJECT, PROVISIONS FOR STORAGE FOR WATER SUPPLY

WHEREAS, the Corps of Engineers, U. S. Army, is making a study of a proposed reservoir project on North Oconee River in Jackson county, Georgia, to provide flood control storage and other water-related uses; and

WHEREAS, under the Water Supply Act of 1958, water supply storage may be include for present or anticipated future demand or need for municipal or industrial water; and

WHEREAS, the City of Jefferson is in need of an additional source of water for municipal and industrial expansion, and is aware of the provisions of the Water Supply Act of 1958 requiring payment by local interest of a portion of the construction costs and a portion of operational and maintenance costs in projects of this nature; and

WHEREAS, the City is vitally interested in the proposed project and desires that a storage be set aside for water supply for the City of Jefferson;

NOW, THEREFORE, BE IT RESOLVED that the City of Jefferson hereby requests the Federal Government to include in its planning for the Curry Creek project, provisions for storage of 900 acre-feet for water supply under authority of the Water Supply Act of 1958; said storage to be sufficient to ultimately provide two million gallons per day.

BE IT FURTHER RESOLVED, that the City of Jefferson hereby pledges to fully cooperate with the Federal Government in the development of plans for the Curry Creek project. It is understood that payment for such storage for water supply could be within a period of time which will permit paying out the costs allocated to water supply within the life of the project, but in no event to exceed fifty (50) years after the date on which the project is first used for the storage of water for future water supply purposes; and upon approval of construction of the project by Congress or when the Government's plans are completed, a firm determination as to the extent the City will participate with the Federal Government in the project will be made.

PASSED BY THE CITY COUNCIL OF THE CITY OF JEFFERSON, this the 8th day of April, 1968.

Jack L. Davison
MAYOR

ATTEST:

Wilda Harvil
Clerk

Figure 7-8

SECTION VIII - COORDINATION IN PLANNING

26. FEDERAL AGENCIES

Throughout planning of the Curry Creek Reservoir project, liaison was maintained with the Federal Departments of Agriculture; Interior; Health, Education and Welfare; Commerce; and the Appalachian Regional Commission, either directly by the Savannah District, or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

Among the Federal agencies which furnished basic data for project planning were the Geologic Survey, Environmental Science Services Administration, the Bureau of Sport Fisheries and Wildlife, the Office of Business Economics, and the Federal Water Pollution Control Administration (FWPCA). The basic data were provided through special reports and regular publications of these agencies. Assistance by other Federal agencies included financial help and technical assistance to state and local agencies and planning groups.

Technical appendices to this report present data pertaining to specific aspects of the Curry Creek Reservoir project as estimated by the author agencies. The findings and recommendations of these agencies will be found in the appendices and are summarized below, together with the responsive action.

Soil Conservation Service

The SCS prepared an investigation report on the North Oconee River watershed in April 1967. The nine small reservoirs would modify the runoff from about 45 square miles and would provide about 10,900 acre feet of flood control storage. About 39 miles of channel improvement was also recommended. This project would be unaffected by Curry Creek Reservoir as the lowermost segment of the channel improvements is above the head of the Reservoir.

Bureau of Outdoor Recreation

BOR evaluated the current and future outdoor recreation needs of the recreation market area of the project and appraised the recreation potential of existing and project facilities to meet the demand. BOR found that there is an existing and future need for swimming, picnicking, and camping facilities, although the existing and soon to be completed water resource projects would provide adequate water areas for boating to about the year 2000. To meet these specific needs, BOR recommended acquisition of 2,000 acres of lands contiguous to the Reservoir to adequately develop the recreation potential of the project. The project was formulated on this estimate. Later estimates, as presented in Appendix F recommends the purchase of 1,500 acres of land. These differences will be resolved through coordination with various local, state and Federal agencies during the advanced engineering and design stage. The proposed project would include these areas and the installation of appropriate facilities.

Federal Water Pollution Control Administration

FWPCA surveyed the available resources and existing and future needs for water supply and water quality control. FWPCA found that there would be a need for future water supply and that the assimilative capacity of the stream was adequate to maintain acceptable standards of water quality at least to year 2020. Conservation storage was included in the proposed Curry Creek Reservoir to provide the identified need for water supply to the year 2020, with reserve capacity to satisfy other needs as they arise.

National Park Service

The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated. Funds in the amount of $20,000 will be provided by the U. S. Department of Interior in A E and D stage.

Fish and Wildlife Service

The Fish and Wildlife Service inventoried the existing fishing and hunting activities in the area which would be inundated by the reservoir. They found that the fisherman-days lost would be only about one percent of the potential fisherman-days of the reservoir, and therefore would be offset by opportunities provided by the project. They concluded that the hunter-days lost should be mitigated by acquisition of 700 acres in the upper reach of Cabin Creek, and recommended installation of a water-control device in the existing County road bridge. These features were included in the project plan. Other recommendations and proposed disposition are as follows:

The costs for providing parking spaces have been included in the report. One-half of the 540 spaces will be provided initially. The remaining spaces will be provided as the need develops over the economic life of the project.

All bridges crossing the reservoir will include sidewalks or catwalks for fishermen. These will be included in the relocations plan.

A zoning plan for reservoir uses will be developed during Design Memo preparation.

The possibility of leaving standing timber in selected cove areas will be coordinated with Fish and Wildlife Service and the Public Health Service during Design Memo preparation. The reservoir area will be cleared only to conservation pool plus 3 feet vertically.

A multi-level outlet will be incorporated into the design of the project. The need for and the details of the design of this outlet will be determined during preparation of the Design Memo.

Fishermen's facilities will be provided in the tailwater area.

Eleven 1-acre sites for fishermen access will be provided on the river between the dam and Athens.

The use of general recreation lands for hunting will be coordinated between U.S. Fish and Wildlife Service, Georgia Game and Fish Commission, Bureau of Outdoor Recreation, and Georgia Department of State Parks.

<u>Bureau of Mines</u>

The Bureau of Mines prepared a report on known mineral resources in the Curry Creek Reservoir area, based on a review of Bureau records and a library search. Their conclusion was that there is no mineral production in Jackson County and that the water development could not have a detrimental effect on mineral resources of the area.

27. STATE AGENCIES

Many of the departments and agencies of the State of Georgia participated in formulation of the Curry Creek plan to assure its compatibility with State plans of development and conservation of water resources. Also, invaluable assistance was furnished to local planning entities by the appropriate State agencies.

The Northeast Georgia Area Planning and Development Commission played an especially prominent role by furnishing basic economic data and developmental projects and, through technical assistance to Jackson County, a participating member of the Commission, formulated a comprehensive plan for Jackson County to assure orderly development of the area surrounding the project.

28. LOCAL GROUPS

Various county, city, civic and business groups were active and enthusiastic participants in evolving the project plan. Such participation and support is essential to assure that a water resource project will be viable and achieve the developmental objectives.

Officials of the City of Athens and all cities, towns, and communities in Jackson County furnished economic data and industrial development information. The Jackson County Planning Commission is cooperating with the Northeast Georgia Area Planning and Development Commission and county and city officials in the establishment of development and land-use controls to insure that the surroundings of Curry Creek Dam and Reservoir will be well planned and result in an unpolluted reservoir and a clean, wholesome project.

29. PUBLIC HEARING

The District Engineer, Savannah District, Corps of Engineers, held a public hearing at Jefferson, Georgia, 29 May 1968, for the purpose of presenting the plan for Curry Creek Dam and Reservoir project to all interested parties in attendance, and to afford them an opportunity to express their views and opposition or support of the project.

The minutes of the hearing show an attendance of 135, representing themselves or various Federal, State, or local governmental agencies, businesses or civic organizations. The minutes indicate all attendees were favorable toward the project except three residents, whose homes are in the potential reservoir area. Although only the three statements by residents in the reservoir area expressed opposition to the project, these statements indicated similar feelings of neighbors. However, the preponderance of statements endorsing or supporting the project and the assurances by the State and Cities of Athens and Jefferson that the requirements of local cooperation would be met are indicative of the vigorous local support of the project necessary for realization of the expansionary potential created by the project.

30. IMPLEMENTATION OF PROJECT PLAN

Fulfillment of the plan for development of Curry Creek Reservoir and its area of influence presented herein will involve support of the construction agency, the Corps of Engineers, by Federal, State, and local agencies. The plan outlined below is considered appropriate, insofar as areal conditions of the period of construction and initial project operation can be anticipated, for implementing the project plan.

The Corps of Engineers will assume responsibility for implementing the project plan, in four stages, as follows:

a. Acquisition of project lands.

b. Construction of Curry Creek Dam and Reservoir, including initial recreation development.

c. Operation and maintenance of the project works.

d. Construction of ultimate reservoir recreation development.

Operation and maintenance of the project works, as stated above, would include all of the project facilities except those exclusively for recreation.

The non-Federal agency responsible for managing the recreation potential would participate in the preparation of the master plan for the initial general recreation and fish and wildlife development of the project. When recreation attendance approaches the capacity of the initial installation, this agency would be expected to participate in the planning of the future recreation installation consonant with the specific recreation needs.

Through its appropriate agencies, the State of Georgia is expected to participate in further planning associated with the Curry Creek Reservoir project by continuing to contribute necessary data, review capability, and advisory opinions as to compatibility with State resource development plans.

In consonance with the Federal Water Project Recreation Act (PL89-72), which states, in part:

> "That it is the policy of the Congress and the intent of this Act that . . . (c) project construction agencies shall encourage non-Federal public bodies to administer project land and water areas for recreation . . . "

it is proposed that the recreation areas and facilities of the Curry Creek Reservoir project should be administered by the Georgia Department of State Parks or such other agency as designated by the State.

SECTION IX - CONCLUSIONS

31. CONCLUSIONS

The goods and services of a multi-purpose water resource development project on the North Oconee River are essential to sustain the economic growth of this segment of Water Sub-region D, as well as in the Athens metropolitan area, and to enhance the aesthetics of the river and its environs. The plan of development presented in this Chapter was formulated to provide the streamflow control required to accomplish the project's objectives and it has been endorsed and supported by the State, county, municipal, business, and civic representatives responsible for areal development planning.

The project consists of a multi-purpose reservoir and access-parking areas along the river channel to Athens. The estimated total construction cost is about $18.5 million, equivalent to an annual value of $915,000, including operation, maintenance, and replacement costs. It is expected that location of processing plants, concomitant with construction of the reservoir project and directly attributable thereto, would result from a developmental investment of $8.8 million. Annual increases of income are estimated to be $1,239,000 nationally and $4.5 million regionally.

The State of Georgia has evinced an intense interest in the formulation of the project plan and has endorsed that plan, as expressed in the Governor's letters of 14 June 1968, included in paragraph 25.